PROJECT MANUAL

Brown Early Childhood Center
Portales Municipal Schools | Portales, New Mexico

Project No: 18-0032
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Construction Documents

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PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This work is associated with the Base Bid.

B. See General Conditions and Supplemental General Conditions.

C. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 21 and form a part of the contract.

D. Division 22 for Plumbing Systems.

E. Division 23 for Heating, Ventilating and Air Conditioning (HVAC) Systems.

F. Division 26 for Electrical Systems.

G. Division 28 for Fire Alarm Systems.

H. Division 31, for Trenching, Backfilling and Compaction requirements.

I. Division 22 for requirements of site utility systems, including sanitary sewer, domestic water distribution system, fire main water distribution system, and natural gas service.

J. All electrical work, regardless of voltage which is provided under Division 21 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 FIRE SUPPRESSION DIVISION INDEX

Section 21 0500	Common Work Requirements for Fire Suppression
Section 21 0501	Demolition for Fire Suppression
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1.3 CODES AND PERMITS

A. The fire suppression shall be performed in strict accordance with the applicable provisions of the International Building Code, 2015 Edition; the Uniform Plumbing Code, 2015 Edition; the Uniform Mechanical Code, 2015 Edition and the International Fire Code, 2015 Edition as adopted and interpreted by the State of New Mexico, City of Portales, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding fire protection, heating and ventilating and air conditioning systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, and tap fees shall be paid for by the Contractor, unless otherwise specified herein.

C. The following lists some applicable codes and standards that shall be followed.

Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances

National Electrical Manufacturer's Association Standards

National Electrical Code

Underwriters Laboratories, Inc. Standards

American National Standards Institute

American Society for Testing Materials Standards

Standards and requirements of local utility companies

National Fire Protection Association Standards

American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

Occupational Safety and Health Act

The American Society of Sanitary Engineering

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all mechanical work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. The Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

    a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
    b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
    c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 21, including but not limited to the following:

1. Piping materials, valves, equipment and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all equipment listed on equipment schedules, and in related construction documents.
2. Materials, certification, shop drawings, and other information as specified in the individual Division 21 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. The Contractor shall submit a maximum of seven (7) copies of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. [One (1) copy of all submittals will be retained by the Engineer. The remaining copies will be returned to the Architect. Additional sets of submittals, if required by the Contractor, shall be reproduced by the Contractor from the reviewed and marked sets returned to the Contractor.

H. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

I. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

J. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

K. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

L. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance.

This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Mechanical equipment rooms.
2. Piping and piping chases.
3. Complete fire suppression system piping and sprinkler head layout.
4. Layout of all fire suppression equipment.

B. Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems and piping, coordinated with plumbing, HVAC and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the fire suppression systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of fire suppression devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8 inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the mechanical systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. Installation of fire suppression work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required

drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.11 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer may require compensation for the time necessary to format the CADD files delivery to the Contractor. Such work will include removal of title blocks, professional for seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.12 PRIOR APPROVAL

A. Equipment manufacturers and service providers are listed within the specifications for the work specified in this division.

B. Manufacturers and service providers who are not listed in these specs, and who offer equivalent or superior products or services, are invited to submit for approval prior to bid (prior approval). Submit two copies. Requests for prior approval must:

1. Include the substitution request form at the end of this spec section.
2. Include technical data sufficient for the Engineer to generally assess appropriateness for this project.
3. Be submitted minimum ten days prior to the bid date in effect at the time of submission.
4. Comply with any additional requirements per specification Division 1.

C. Any additional prior approved alternate manufacturers and service providers will be published in an addendum prior to bid. Prior approval indicates that based on the information submitted it appears to the Engineer that the alternate might be capable of meeting the specifications and the design intent, and might be appropriate for the project. But prior approval does not guarantee this. Prior approved products and service providers must still go through the submittal process after award, and must still comply with the design intent and all specification requirements.

D. Please do not request prior approval for products and service providers that are not listed above. Instead, for those items alternate manufacturers and alternate service providers may be submitted after bid in accordance with the submittal process, provided they meet or exceed the specifications and the indicated design intent.

1.13 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

> "The Contractor guarantees that this installation is free from mechanical defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704," or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of fire suppression equipment shall be provided with a full one (1) year parts and labor warranty, from the date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of fire suppression equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 3700 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 21 0549, Fire Suppression and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to

ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The fire suppression piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.4 PAINTING

A. All finish painting of fire suppression systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.5 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve [and system valve numbers and designations shall be coordinated with existing valve identification. The Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Submitted drawings shall be neat and easily readable. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 21. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 21 valve tags shall be coordinated with Division 22 and Division 23 valve tags for coordinated format between each division.

2.6 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

- Adjacent to each valve in piping system.
- At every point of entry and exit where piping passes through a wall.
- On each pipe riser and junction.
- At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
- Adjacent to all special fittings (regulating valves, etc.) in piping systems.
- At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow - Hazardous Materials
Green - Liquid Materials of Inherently Low Hazard
Blue - Gaseous Materials of Inherently Low Hazard
Red - Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. All piping shall be identified in a manner matching the existing labeling systems.

I. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

J. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Fire Protection Water	White	Red
Fire Auto Sprinkler	White	Red
Fire Dry Standpipe	White	Red
Fire Wet Standpipe	White	Red
Fire Combination Standpipe	White	Red

2.7 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified.

2.8 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.9 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction, or Milcor institutional 10 gauge security/detention access door with welded joints, welded butt hinge, with detention type deadbolt lock and tamperproof screws.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DESIGN AND DRAWINGS

A. The complete design for the project fire suppression system including drawings, hydraulic calculations, piping sizing and arrangement, head layouts, equipment selection, etc., shall be the responsibility of Division 21 Contractor. Preparation of the fire suppression system design shall be in accordance with all Division 21 specification requirements, NFPA requirements and Authorities Having Jurisdiction.

B. The fire suppression drawings show the general arrangement of piping, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents, including but not limited to Division 22 Plumbing, Division 23 Heating Ventilating and Air Conditioning and Division 26 electrical shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural and structural drawings shall take precedence over the fire suppression, plumbing, HVAC and electrical drawings. Because of the small scale of the fire suppression drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefore shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior written approval. All changes shall be marked on the set of record drawings by the Contractor.

C. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

D. Installation of all fire suppression equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum

clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within mechanical equipment rooms.

E. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 21 with the associated architectural, structural, and electrical work than is normally necessary for a more typical facility.

F. The installation of all concealed fire suppression systems shall be carefully arranged to fit within the available space without interference with adjacent mechanical, plumbing, structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed fire suppression systems, including access doors; sprinkler piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the fire suppression system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all fire suppression work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the fire suppression work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Division 21 Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades 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 pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of fire suppression, plumbing and HVAC systems within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the mechanical work to the building structure to prevent damage of equipment and systems due to earthquakes. The complete fire protection systems shall be supported as required to resist stresses produced by lateral forces as required by NFPA No. 13. Where fire suppression equipment and piping is connected to the building structure, exact method and means of attachment to the structural system shall be approved by the Architect.

B. See Section 21 0548 for additional requirements for seismic supporting of fire suppression equipment and systems.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of fire suppression equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Architect. Equipment shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gyp board sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Architect.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fire suppression equipment and materials shall be cleaned thoroughly and delivered in a condition satisfactory to the Architect.

3.7 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the fire suppression installation shall be provided by this Contractor.

3.8 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.9 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.10 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

3.11 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of fire suppression equipment herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, bearings, shafts, etc. Furnish two (2) copies of all the literature; each shall be suitably bound in loose leaf book form.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

D. Upon completion of all work and all tests, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

E. Film the instruction and training sessions submit two copies of the DVD.

F. Equipment startup and operational test shall be conducted by the Contractor with the assistance of the representatives from the fire pump manufacturers and fire pump controller manufacturer. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.12 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.13 INTERRUPTING SERVICES

A. The Contractor shall coordinate the installation of all fire suppression system work in order to minimize interference with the operation of existing building mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

3.14 CONSTRUCTION PHASING AND SCHEDULE

A. All work furnished and installed under Division 21 of this Specification shall be provided in accordance with the project schedule and phase and schedule requirements as described on the Architectural Drawings and Specifications.

3.15 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 210500

DIVISION 21 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.**
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:
Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____
Proposed Substitution: _____
Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain: _____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades? _____

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____

7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____

9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted _____ Not Accepted: _____ Received too Late: _____
By: _____ Date: _____
Remarks:

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 210503 - TRENCHING AND BACKFILLING FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 21.

B. The Contractor shall provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplemental General Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0503, for applicable requirements.

END OF SECTION 210503

SECTION 210504 - PIPE AND PIPE FITTINGS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 21, shall be lead free. The term lead free is defined as pipe which does not contain more than 8.0% lead and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 21 0500 for Common Work Requirements for Fire Suppression.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, seismic restraints, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 21, Section 21 1313 for applicable requirements.

PART 3 - EXECUTION

See Division 21, Section 21 1313 for applicable requirements.

END OF SECTION 210504

SECTION 210505 - PIPING SPECIALTIES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

C. Section 21 0523, Valves for Fire Suppression.

D. Section 21 0549, Fire Suppression and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0505, for applicable requirements.

END OF SECTION 210505

SECTION 210523 - VALVES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: Valves shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0523, Valve Identification for Fire Suppression.

C. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

D. Division 23 for Valves.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Fire Suppression system valves shall be UL Listed and FM Approved. See applicable fire suppression system specification sections for additional valve requirements, including hose threads, tamper switches, etc.

B. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Grinnell, Victaulic, Nibco, or Dezurik, or equivalent.

PART 2 - PRODUCTS

See Division 21, Section 21 1313, for applicable requirements.

PART 3 - EXECUTION

See Division 21, Section 21 1313, for applicable requirements.

END OF SECTION 210523

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE PROTECTION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Works Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings.

C. Section 21 0900, Instrumentation and Control for Fire Suppression System.

1.3 SCOPE

A. It shall be understood that the requirements for seismic restraints are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements for seismic restraint as specified herein, shown on the drawings and required by Code.

B. The work under this section shall include furnishing all labor, materials, tools, appliances and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed and/or scheduled on the drawings and/or specified in this section of the specifications.

C. The materials and systems specified in this section shall be provided by the Contractor from a single Seismic Snubber Restraint Materials Manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

D. The seismic snubber restraint materials manufacturer shall be responsible for detailed design for seismic supports, including calculation for size and attachment, signed and sealed by registered State of New Mexico Structural Engineer.

1.4 SUBMITTALS

A. See Section 21 0500 for general requirements for submittal materials. In addition to the requirements contained in Section 21 0500, provide submittal information for all products and materials covered under this Section of the Specifications as listed herein.

B. Furnish complete catalog data on all vibration isolators, restraints, and equipment vibration bases to be utilized for the project in order to establish compliance with the plans and specifications and all code requirements.

C. Furnish complete shop drawing information including construction details for all vibration bases; support points and anchor bolt requirements and locations; method of support for piping; method of isolation for piping passing through the building structure; and location and arrangement of seismic restraints.

D. Manufacturers not listed as approved in 'Part 2 - Products' must submit for prior approval in accordance with provisions contained in Section 23 0500.

E. Drawings shall be reviewed and certified by a registered Professional Engineer, with a minimum of five (5) years working experience in this field, certifying that the submitted seismic restraint system design and anchorage details complies with all specification requirements and applicable codes.

1.5 CODE REQUIREMENTS

A. Seismic restraints shall be provided for equipment, materials and systems furnished and installed under Division 21 of this Specification in accordance with the requirements of the 2012 International Building Code; and NFPA No. 13 for fire protection system as adopted and interpreted by the State of New Mexico and the City of Portales.

1.6 PROJECT SEISMIC PARAMETERS

A. The following parameters shall be based on Structural Calculations and should be used to evaluate the seismic requirements of the mechanical systems and components. See structural drawings for additional information:

Risk Category	III
Seismic Response Coefficients	SDS=0.087 SD1=0.053
Site Soil Class	D
Seismic Design Category	A

1.7 SEISMIC RESTRAINT REQUIREMENTS

A. The Contractor shall submit calculations prepared by a State of New Mexico licensed Structural Engineer to substantiate that all items of fire protection equipment and piping systems are properly supported to resist earthquake forces as required herein.

B. All fire protection equipment mounted on vibration isolators shall be provided with seismic restraints securely anchored to the building structure capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

C. All items of fire protection equipment required for life safety including the fire pump and fire protection systems shall be provided with seismic restraints securely anchored to the building

capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

D. All items of fire protection equipment, except as specified above, and all piping furnished and installed under Division 21 shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 50% of their weight.

E. Seismic restraint/snubber manufacturer shall be responsible for the structural design of attachment hardware as required to attach seismic restraints/snubbers to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

F. The Contractor shall furnish a complete set of approved shop drawings of all mechanical and electrical equipment which is to be restrained to the seismic restraint manufacturer, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, installed operating weights of the equipment to be restrained and the distribution of weight at the restraint points.

PART 2 - PRODUCTS

See Division 23, Section 23 0548, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0548, for applicable requirements.

END OF SECTION 210548

SECTION 210549 - FIRE SUPPRESSION AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 21 0500, Common Work Results for Fire Suppression.

B. Division 22 for Plumbing Systems.

C. Division 23 for Facility Management System.

D. Division 26 for Electrical.

E. Division 28 for Fire Alarm System.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 21 according to Table 1.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 21	Div. 21	Div. 26	Div. 21
Fire Alarm System & Interface w/Fire Suppression Systems		Div. 28	Div. 28	Div. 28	Div. 28
Fire Pump Systems, including main pump & jacket pump control panels, automatic transfer switches and remote monitoring panels		Div. 21	Div. 21	Div. 26	Div. 21
Fire Sprinkler System Control - Supervisory Panels & Devices, Including Tamper Switches & Flow Switches		Div. 21	Div. 21	N/A	Div. 28

TABLE NOTES:
1. Unless specified to be supplied with the equipment

END OF SECTION 210549

SECTION 211313 - FIRE PROTECTION SYSTEM, AUTOMATIC WET-PIPE SPRINKLER

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplement General Conditions and the General Requirements.

B. Division 3 for concrete work.

C. Division 26 for electrical work and building fire alarm system.

D. Architectural Sections of this Specification for required cutting, patching, painting, required in conjunction with the installation of the new sprinkler system within the existing facility.

1.2 RELATED SECTIONS

Section 21 0500	Common Work Requirements
Section 21 0503	Trenching and Backfilling for Mechanical Systems
Section 21 0504	Pipe and Pipe Fittings
Section 21 0505	Piping Specialties
Section 21 0523	Valves
Section 22 6801	Outside Utilities
Section 23 0549	Fire Suppression and Electrical Installation Coordination
Section 23 0900	Facility Management System
Section 23 3000	Air Tempering System and Equipment
Section 28 3100	Fire Detection and Alarm

1.3 SCOPE

A. Criteria: This Section covers the requirements for furnishing the design, fabrication, installation, and acceptance testing of a complete automatic wet-pipe sprinkler system.

B. Classification: In accordance with NFPA 13 and 101 requirements and recommendations.

C. Scope of Work: Provide the design, materials, equipment, fabrication, installation, labor, and supervision necessary to install, disinfect, flush, test, and place into service a complete wet-pipe sprinkler system.

1. Upright and pendant fire sprinkler protection shall be provided throughout all areas of the facility where wood is present within the ceiling cavity.
2. Fully sprinkle the facility per NFPA-13, the International Building Code, International Fire Code, state and/or local Fire Marshal, and any specific requirements of the Owner's insurance underwriter.

D. Components: Provide all piping, fittings, control valves, check valves, alarm valve (with trim), tamper switches, fire department connection, sprinkler heads, hangers, bracing, test and drain connections, zone flow switches, tamper switches, accessories and incidentals required for a complete installation in accordance with codes and standards referenced in this Section.

E. Protect all fire lines subject to freezing in a manner approved by NFPA. Use anti-freeze loops only as approved by NFPA and the Local Fire Marshal and only with approved backflow protection in accordance with applicable building codes. Electric heat tape will not be permitted.

F. Conform to the applicable provisions of NFPA Standards 13 and 101 and to the requirements of the International Building Code. Unless otherwise shown on the Drawings or specified, all materials and equipment used in the installation of the fire protection systems shall be listed in the UL Fire Protection Equipment Directory, and shall be the latest design of the manufacturer. All fire hoses, threads and adapters shall match the standards of the City of Portales.

G. Provide temporary fire protection within all areas of the building under construction as required by the building codes and the Fire Marshal.

1.4 QUALITY ASSURANCE

A. All materials and equipment used in the installation of the fire protection systems shall be UL listed and/or FM approved for intended use, unless stated otherwise in these specifications.

B. Contractor Qualifications: Contractor shall be experienced, licensed and regularly engaged in the design, fabrication, and installation of automatic fire protection sprinkler systems.

C. Certification: Welders and brazers shall be qualified per the ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

D. Employ skilled craftspersons and provide proper supervision to ensure the work is erected in a proper manner. Coordinate the work with existing conditions and other disciplines. Visit the premises and thoroughly understand the details of the work and working conditions, and verify all dimensions in the field. If discrepancies are noted which require clarification of the design intent, submit RFIs prior to performing related work. Lay out all work in a manner to avoid all interferences.

E. The drawings show only approximate building outlines and interior construction details as an aid in understanding the scope of work. Follow the drawings as closely as building construction and the work of other trades will permit. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such fittings, traps, valves, and accessories as may be required to meet such conditions. Field verify all dimensions and conditions governing the work.

F. Do not render inoperative any building system without prior approval. Coordinate necessary shutdowns through seven day advanced written notification.

G. Coordinate all fire protection piping and sprinklers with the ceiling or roof materials, lighting, ductwork, conduits, piping, suspended equipment, structural, and other building obstructions to provide an installation in compliance with the appropriate building codes, and NFPA Standards.

1.5 EXISTING CONDITIONS

A. Examine existing conditions and related work required for the design and installation of the fire suppression system.

B. Perform all field tests and inspections as may be necessary to determine water flow, fire protection and pressure characteristics (static and residual pressure and residual flow) necessary for the design and installation of the fire protection system. Contact the water utility to determine whether they anticipate any degradation in the available water source. Prior to starting design, procurement, and installation, submit to the Owner and Engineer a written report documenting the results of this discussion with the water utility.

1.6 INTERRUPTING SERVICES

A. Coordinate the installation of all work in order to minimize interference with the operation of existing building and mechanical, plumbing, fire protection and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtime. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written approval.

B. All work requiring deactivations of the existing fire protection systems for new connections, relocations, removals, etc, shall be carefully coordinated with the Owner and the Fire Marshal and shall be arranged to minimize system downtime. The Contractor shall provide for all additional costs, as may be required, for work during non-standard hours in order to provide interconnection and interface with the existing fire protection system in order to minimize system deactivation time.

1.7 OPERATION PRIOR TO ACCEPTANCE

A. The Owner may wish to place portions of the fire suppression systems in service prior to substantial completion. In this case, a written agreement will be prepared establishing warranty and other responsibilities to the satisfaction of both parties.

1.8 SUBMITTALS

A. See Division 1 and Section 21 0500 for general submittal requirements.

B. Within 45 days after the contract is awarded, provide submittal data for the complete fire suppression system for review.

1. Submit sprinkler system design drawings and hydraulic calculations to the Fire Marshal, the Building Department AHJ, and the Owner's Insurer for review, comment, and approval.

    a. Drawings must be prepared by either a minimum Level 3 NICET Certified Technician, or a professional engineer.
    b. Drawings must be stamped by a professional engineer registered in fire protection.

2. Upon receipt of stamped and approved system design drawings and hydraulic calculations from the Fire Marshal, the Building Department AHJ, and the Owner's Insurer, submit required sets of complete submittal data to the Architect as per spec Section 21 0500.

C. Submit complete data describing all equipment and materials to be furnished including performance, quality, dimensions, and certifications of approving agencies. Include plans showing location and arrangement of water supply connection, control valve, fire department connections, alarm bells, tamper switches, on-site fire main routing, on-site fire hydrants and other equipment to be used; and including head layouts coordinated with lighting, plumbing and air conditioning systems. Submittals shall include the following:

1. Shop drawings.
2. Certifications (after installation and tests are completed).
3. Equipment list.
4. Material list.
5. Installation instructions.
6. Maintenance instructions.
7. Operating instructions.
8. Samples, colors.
9. Welder's certification.
10. Catalog data (appropriate unit identified on cut).
11. Recommended spare parts lists.
12. Verifiable calculations.
13. Nameplate data.

D. Complete Package: Submit fire suppression work as a complete package to permit analysis of the system(s) and its components. Partial submittals will not be accepted.

E. Hydraulic Calculations: Submit computerized hydraulic calculations. Maintain a minimum of 10 percent, but not less than a 5 psi buffer below the final water supply curve after accounting for required hose streams, pipe friction elevation differences, etc. Hydraulic design sprinkler system shall be in accordance with the following:

1. Sprinkler System Occupancy Hazard Classifications:

    a. Office and Public Areas: Light Hazard
    b. Storage Areas: Ordinary Hazard
    c. Equipment Rooms: Ordinary Hazard
    d. Service Areas: Ordinary Hazard

2. Minimum Density Requirements for Automatic Sprinkler Hydraulic Design:

   a. Light Hazard Occupancy: 0.10 gpm over 1500 sf area.
   b. Ordinary Hazard, Group 1 Occupancy: 0.15 gpm over 1500 sf area.
   c. Ordinary Hazard, Group 2 Occupancy: 0.20 gpm over 1500 sf area.
   d. Special Occupancy Hazard: As determined by authority having jurisdiction.

F. Shop Drawings: Minimum 1/8" = 1'0" for plans, and 1/4" = 1'0" for details, with minimum 3/16 inch lettering. Show all piping, sprinklers, hangers, flexible couplings, roof construction, electro-mechanical devices, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. Show hydraulic reference points and remote areas.

G. Record Drawings: Provide mylar reproducible record drawings and AutoCAD 2008 files showing all work under this contract. Indicate any special systems or devices such as dry pendant heads, antifreeze loops, inspector's test connections, etc. Submit record drawings prior to requesting final payment.

1.9 PRODUCT HANDLING

A. Materials and Equipment: Protect materials and equipment from damage during shipping, storage, and installation.

B. Materials and Equipment Installation: Ensure materials and equipment are free of moisture, scale, corrosion, dirt, and other foreign materials prior to installation.

C. Plugs and Cover Plates: Protect flanged openings with gasketed metal cover plates to prevent damage during shipment. Cap or plug all drains, vents, and small piping or gauge connections.

D. Sprinkler Head Protection: Remove frangible bulb protectors after sprinkler heads are installed. Protect sprinkler heads with factory-supplied caps and covers until ceiling installation is complete.

1.10 ENVIRONMENTAL CONDITIONS

A. The sprinkler system and system components shall be designed to operate at an elevation of 3700 feet above sea level and in freezing temperatures when exposed to outside conditions.

1.11 ALARM FACILITIES

A. Provide water flow switches and tamper switches. Integrate these and other required sprinkler system alarm devices into the building fire alarm system provided under Division 26. Coordinate with Division 26, Fire Detection and Alarm, regarding the requirements and location of items provided under this section which must be integrated with the fire alarm system.

B. Provide tamper switches on all required valves and devices used in conjunction with the building fire protection system.

1.12 ELECTRICAL CONNECTIONS

A. The fire alarm system will monitor waterflow indicators, tamper switches, etc., provided under this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All material and equipment furnished shall be in accordance with the following requirements and NFPA 13. All fire protection materials and equipment shall be new and unused, shall be free of defects and specifically designed for the use intended, shall conform to the requirements of NFPA 13, and shall be UL listed and FM approved, unless otherwise noted in the Specification.

B. Any deviation to the above requirements shall be submitted to the Architect for approval. The deviation submittal shall be clearly identified as a "deviation."

2.2 PIPING MATERIAL

A. Material Requirement: Automatic sprinkler piping shall be in accordance with this Section and NFPA 13, respectively.

B. Underground piping, to a point 5'0" from the building perimeter, shall be as specified for underground water services in Section 22 6801, Outside Utilities, of this Specification.

C. Underground piping within the building and to a point 5'0" from the building perimeter shall be AWWA Class 200 ductile iron water main pipe and fittings with mechanical joints. Interior of pipe and fittings shall be cement lined. Exterior of pipe and fittings shall be bituminous coating or equivalent. All changes in direction shall be adequately blocked or strapped to prevent separation of joints.

D. Interior building piping systems shall be black steel pipe ASTM A120, or A53 Grade A or B, ERWQ or BW, Standard wall, Schedule 40. UL and FM approved thin wall (Schedule 10, minimum) ASTM A135 or A795 piping may be utilized for sprinkler system as allowed by NFPA and the Fire Marshal. Piping installed outside or exposed to outdoor ambient conditions shall be galvanized.

2.3 FITTINGS

A. Changes of direction shall be accomplished by the use of fittings suitable for use in sprinkler systems as defined in Article 3-13 of NFPA 13. Fittings installed outside or exposed to outdoor ambient conditions shall be galvanized.

B. Fittings and specials for ductile iron pipe shall be Class 250 to match pipe, conforming to AWWA C110, mechanical flange joint type. All ductile iron fittings shall be cement lined.

C. Fittings for steel pipe shall be cast iron screwed, welded fittings, or UL and FM approved mechanical pipe couplings and fittings as manufactured by Victaulic or equivalent in accordance with requirements specified in Section 21 0504.

2.4 JOINTS

A. Joints shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings, and the manufacturer's instructions. Threaded joints for thin-wall (Schedule 10) piping shall be provided in strict accordance with NFPA requirements, UL and FM approvals for threadable thin-wall piping.

2.5 UNIONS AND FLANGES

A. Unions and flanges shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings. Gaskets shall be as recommended by the manufacturer and suitable for service on which used.

2.6 HANGERS AND SUPPORTS

A. See Section 21 0504, Pipe and Pipe Fittings, for general requirements associated with equipment piping systems hangers and supports. Seismic supports for fire protection system shall be provided in accordance with NFPA requirements.

B. All fire protection piping shall be rigidly supported from the building structure by means of adjustable ring type hangers. Piping hangers shall be spaced as specified in NFPA 13, Chapter 2. Piping system shall be installed in an approved manner and shall not overload the structure. The Contractor shall provide additional hangers and steel support members as may be required to distribute the piping weight over several structural members where required or directed. Fire protection piping system shall be supported independent and shall not be attached or supported from hangers, trapezes, or supports provided for other piping systems or equipment.

2.7 VALVES

A. See Section 21 0523, Valves, for general valve requirements. All valves for fire hose fire department connections shall have threads and adapters to match the standard of the City of Portales Fire Department. All valves shall be UL listed and FM approved. Valve sizes shall be determined by the approved hydraulic calculations. Outside screw and yoke valves shall be indicated on the approved hydraulic calculations. Tamper switches shall be provided on all valves controlling fire protection system operation, as required by NFPA. Valves shall be rated for working pressure not less than the maximum pressure to be developed at that point in the system under any operating condition.

B. Gate valves 2" and under, shall be bronze body and trim, outside screw and yoke, wedge disc, screwed connections, 400 psi W.O.G. maximum working pressure.

C. Gate valves, 2-1/2" and larger, shall be Class 125 or Class 250, as required, with flanged ends, outside screw and yoke, bronze seals, wedge disc, iron body.

D. Drain valves shall be globe valve or angle body globe valve, with screwed ends, bronze body and trim, 200 psig W.O.G. maximum working pressure. Furnish and install as required by NFPA No. 13.

E. Swing check valves 2" and smaller shall be y-pattern, horizontal swing bronze body, bronze trim, 200 psig W.O.G. screwed connections.

F. Swing check valves 2-1/2" and larger, shall be iron body, clearway swing check, Class 125 or Class 250 as required with flanged or grooved connections.

G. Automatic Ball Drips: Automatic ball drips shall be 1/2" or 3/4" as required normally open, which close when the flow of water through the valve exceeds 4 to 10 gpm, 175 psig working pressure, Underwriters' Laboratories, Inc., or Factory Mutual approved, Standard Fire West No. 5248 or equivalent.

H. Post indicator fire main control valve shall be vertical post type for underground valve control provided as shown on the Drawings, Underwriters' Laboratories, and Factory Mutual approved pattern with approved gate valve and tamper switch. See Section 22 6801 for vertical post indicated and underground valves. Vertical post indicator shall be Mueller Co. Model A-20804 with Mueller AWWA non-rising stem gate valve, A-2050 Series or equivalent.

2.8 ALARM CHECK VALVES

A. Furnish complete wet-pipe sprinkler system alarm check valve assembly with all accessories required for system operation, supervision and alarm. Valves shall be UL listed and FM approved, designed to automatically activate electrically and/or hydraulically operated alarms and shall be furnished in the required size and arrangement with either flanged or grooved connections.

B. Furnish retard chamber, pressure gauges, valves, and trim including water motor gong and alarm switch with both normally open and normally closed electrical contacts.

C. Alarm check valve assembly shall be as manufactured by Tyco Fire Products or equivalent.

2.9 PRESSURE GAUGES

A. Pressure gauges shall be designed for use with water. Gauges shall be of the Bourdon type having an enclosed phosphor-bronze type. The moving parts shall be brass or stainless steel except the hairspring, which is phosphor-bronze. The case and ring shall be brass or stainless steel, and the ring shall be either threaded or pressed over the case. Gauges shall be 4-1/2 inch size with dial marking subdivisions no finer than one percent of the maximum scale reading, and shall be accurate to two percent or less. The gauge scale, when possible, shall be at least twice the maximum working pressure. All gauges shall be FM approved and UL listed.

2.10 TAMPER SWITCHES

A. All valves which control water to automatic sprinkler heads shall be equipped with supervisory switches having one normally open contact and one normally closed contact. Valve supervisory switches shall be single pole double throw switching contacts, and shall be housed in a gasketed weathertight enclosure. The supervisory device supplied shall be specifically designed to mount on, and operate reliably with, the type of control valve being monitored. All valve position switches shall be adjusted to transmit a supervisory signal within two revolutions of the valve operating hand wheel or crank (away from its full open position).

2.11 FLOW SWITCHES

A. Water flow switches shall be field adjustable vane-type with pneumatic retard and 175 psi working pressure. Units shall be single pole double throw, normally open, suitable for 24-volt, DC service or as otherwise required to interface with Building Fire Alarm system. Water flow switches shall be adjusted so that the device will transmit a water flow alarm within 90 seconds of opening the inspector's test valve on the sprinkler system. The flow switch shall be furnished and installed under this Section of Specifications and electrically connected under Division 26. Flow switches when required for zoning shall be piped and installed so that only one flow switch actuates when an alarm in that zone is present.

2.12 SPRINKLER HEADS

A. Sprinkler heads and accessories shall be UL listed or FM approved for the intended service, quick response automatic closed type, 165 deg F rated with 1/2" orifice, except as may be otherwise required for the specific application, and subject to NFPA 13 and 101 requirements and recommendations. Sprinkler heads with higher temperature ratings shall be installed in electrical and mechanical equipment areas, in areas where occupancy may generate high ambient temperatures, where installed in the vicinity of heat producing equipment, attic spaces, where exposed to the direct rays of the sun and beneath skylights and windows, and at other such locations as required by NFPA 13.

B. Sprinkler heads installed in unfinished areas without suspended ceilings shall be upright bronze or brass. Sidewall type heads may be used in areas with low headroom as approved by the Fire Marshal.

C. Sprinkler heads in areas with suspended ceilings including toilet facilities, storage rooms, and similar building spaces shall be chrome plated bronze pendant type or white painted finish as selected by the Architect unless otherwise noted. Sidewall heads in finished areas shall be horizontal, chrome plated bronze.

D. For all building areas, except as indicated above, furnish concealed sprinkler heads consisting of sprinkler head installed within brass enclosure assembly with cover plate with white finish or satin chrome, as approved by the Architect.

E. Supply spare heads of each type as required by NFPA 13. Provide a metal cabinet with a sprinkler head wrench for each type head.

F. Provide sprinkler head guards where required by NFPA 13 and where appropriate.

G. Approved Manufacturers: Tyco Fire Products, Viking, or equivalent.

2.13 SYSTEM ACCESSORIES

A. Fire Department Connections: Fire department connections shall be of the type and style shown on the fire protection drawings, cast brass body, double clappers, plugs, and attached chains. All exposed surfaces, caps and chains shall be chrome plated. Identification shall be by raised letters on the individual devices, or shall consist of attached escutcheon plates of the same material. Label shall read "AUTO SPKR". The dimension from grade level to the center of the 2-1/2-inch inlets shall be 34 inches (plus or minus 2 inches). Make the fire department connection above the inlet to the alarm valve.

B. Plaques: Main riser plaques shall be 7 inches by 10 inches with four mounting holes (one in each corner), and shall have white lettering on red porcelain with white blank for the "design data." Plaque shall meet all requirements of NFPA 13, Chapter 7.

C. Strainers: Strainers, where required, shall be "Y" type with cast iron body, 30 mesh monel screen, flanged ends, 1-1/2-inch blow down connection discharging to outside, and shall be rated at 175 psi working pressure for cold water service.

D. Splash Blocks: Splash blocks shall be concrete, 12 inches by 24 inches by 4 inches thick. A commercially available splash block may be provided as a suitable alternate.

2.14 ACCESS DOORS

A. All concealed valves, controls, etc., shall be provided with access doors as specified under Section 21 0500, Common Work Requirements.

PART 3 - EXECUTION

3.1 FIELD CONDITIONS

A. Prior to installation the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where the installation of the sprinkler system may properly commence.

B. The Contractor shall verify that the entire sprinkler system may be installed in accordance with all referenced codes, regulations, standards, and the original approved design.

3.2 INSTALLATION

A. General

1. The complete fire protection system shall be installed in accordance with NFPA 13. The project drawings provide general information concerning the system arrangements, equipment, material, sizes, and other requirements and shall be utilized by the Contractor for this purpose. However, the Contractor shall have complete responsibility for the system design and installation in accordance with the requirements of this Specification.
2. All pipe, fittings, valves, equipment, and accessories shall be visually examined to ensure that they are clean and free of all burrs, cracks, and other imperfections before being installed. During the progress of construction, open ends of pipes, fittings, and valves shall be properly protected at all times to prevent admission of foreign matter.

B. Piping

1. Installation of fire sprinkler piping system shall be in accordance with all applicable requirements contained in Section 21 0500 – Common Work Requirements, Section 21 0504 – Pipe and Pipe Fittings, and Section 21 0505 – Piping Specialties.
2. All fire sprinkler piping shall be so arranged and include such devices to separate the system into individual and distinct alarm zones as shown on the contract drawings and as required by NFPA recommendation and the Fire Marshal. A minimum of one zone per floor will be required unless shown otherwise on the contract drawings.
3. Sprinkler piping shall be marked and identified in accordance with Section 21 0500, Common Work Requirements.
4. The arrangements of all piping systems shall conform to Architectural requirements and field conditions, and shall be run straight and direct, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be provided where required. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, and shall be parallel with the walls and other pipes and shall be neatly spaced. All work shall be coordinated with all Sections of Division 21, 22, and 23, and Division 26, "Electrical," in order to avoid interference of pipe and unnecessary cutting of floors and walls.
5. No pipes or other apparatus shall be installed so as to interfere in any way with the full swing of the building doors, access doors, equipment access, etc.
6. Inspector's test and test pipes shall be piped from the end of the most remote branch line of the automatic sprinkler system to the exterior of the building.
7. When trapped capacity is more than five gallons, provide auxiliary drains consisting of a one-inch valve, nipple, and cap. When trapped capacity is less than five gallons, auxiliary drain shall be one-inch nipple and cap or plug.
8. Provide main drain valves at system alarm valves and extend piping to discharge at exterior at a location approved by the Architect. All pipe and fittings downstream of drain valve shall be galvanized.
9. All concrete penetrations shall be sleeved, then grouted and sealed with fire-resistive material that shall be securely held in place.

C. Welding

1. No field welding of sprinkler piping shall be permitted.
2. Headers, risers, feed, crossmains, and branch lines may be shop welded using approved welding fittings. Welding and brazing shall conform to American National Standard Institute for Power Piping, ANSI B 31.10, with Addenda ANSI B 31.10a and ANSI B 31.10b. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler systems.
3. Provide a blind flange at each end of welded headers.
4. Welders and brazers shall be certified for welding and/or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators. Welders must be certified for work they perform, and certificates shall be checked before the work commences.

D. Alarm Check Valve: Alarm check valves shall be installed with the valve and trim set plumb, and shall be unobstructed. Clear distances shall be as listed below:

Rear:	12 inches
Sides:	18 inches
Front:	24 inches

E. Control Valves: OS&Y fire protection control valves shall be installed so that the stem can be readily seen.

F. Sprinklers and Accessories

1. Sprinkler heads in finished areas are to be installed on a true axis line in both directions with a maximum deviation from the axis line of 1/2" plus or minus. Heads exceeding this shall be removed and reinstalled. Sprinkler heads shall be located in the center of the ceiling tiles, unless otherwise directed.
2. Provide chrome-plated escutcheons where exposed piping passes through finished floors, walls, partitions, and ceilings. Secure plates to pipe with setscrews or spring clips.
3. Provide spare sprinkler head cabinets per NFPA 13.

3.3 EQUIPMENT INSTALLATION

A. Installation of all devices or equipment not specifically covered by these Specifications shall be in accordance with manufacturer's instructions.

3.4 TEMPORARY FIRE PROTECTION

A. During the construction of the building and until the permanent fire extinguishing system has been installed and is in service, temporary fire protection shall be provided as required by the Fire Marshal.

3.5 INSPECTION AND TESTING

A. The complete fire protection systems and piping acceptance testing shall be performed by the Contractor and witnessed. Advance notice shall be given by the Contractor prior to any tests.

B. Inspection Prior to Testing: The Contractor shall submit notification upon completion of the installation of all materials and equipment.

C. Water Piping Disinfection: The Contractor shall furnish all hoses, connections, and equipment to flush piping clear and free of debris and to rinse piping of disinfectant. Flushing per NFPA Figure A-10.10-2.1. All fittings and connections required for water piping, flushing, and disinfection shall be furnished by the Contractor.

D. Chlorine Application: Water from the existing distribution system, or other approved supply source, shall be made to flow at a constant measured rate into the newly installed piping. The water shall receive a minimum chlorine dosage of 300 mg/1. The Contractor shall not allow any anti-freeze glycerine to come in contact with the chlorine. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of chlorinated water that will expose all interior surfaces to a concentration of at least 30 mg/1 for at least three hours. The application shall be checked at a tap near the downstream end of the line by chlorine residual measure. The chlorine residual measurement test shall be performed by the Contractor and the results submitted.

E. Final Flushing: After the applicable retention period, the heavily chlorinated water in the entire system shall be flushed until the chlorine concentration is not higher than that of the source.

F. Pressure Testing: Pressure tests shall consist of at least flushing, hydrostatic testing, and operation testing and shall be performed in strict accordance with the requirements of NFPA 13. For all above-grade piping, test pressure of 200 psi shall be held for a continuous period of two hours with no drop in pressure. Each complete system (main riser with all associated piping and alarms) shall be tested and accepted as a complete unit. System pressure test shall be against a blank test flange and not against a valve seat. Tests may be conducted by the Contractor on small sections of each complete unit for the benefit of the Contractor. An air pressure test may be provided in accordance with NFPA 13. An air pressure of 40 psig shall be pumped up, allowed to stand 24 hours, and all leaks which allow a loss of pressure over 1.5 psig during the 24 hours shall be fixed.

G. Unsatisfactory Tests: If any of the above tests fail to produce satisfactory results, tests shall be repeated at no additional cost to the Owner until satisfactory results have been obtained.

3.6 CERTIFICATION

A. The Contractor shall certify that the system has been installed in accordance with all referenced codes and standards. The Contractor shall submit this certification upon completion of tests.

3.7 MAINTENANCE AND OPERATING INSTRUCTIONS

A. System description, system theory of operation, and system final inspection and acceptance documents of the completed system shall be submitted in a bound book (four copies). The maintenance manuals and instructions shall include a brief description of the type of system installed, routine-type work defined by step-by-step instructions that should be performed to ensure long life and proper operations, and the recommended frequency of performance. The instructions shall also include possible trouble spots with diagnosis and suggested correction of each. The theory of operation brochures shall describe the function of each component or subassembly. A copy of the completed Contractor's Materials and Test Certificate (reference NFPA-13, Chapter 24) shall be included to document the final inspection, operating test, acceptance and placement of system in service.

END OF SECTION 211313

SECTION 220500 - COMMON WORK REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent Sections of Division 22 and form a part of the contract.

C. Division 21 for Fire Suppression Systems.

D. Division 23 for Heating, Ventilating & Air Conditioning (HVAC) Systems.

E. Division 26 for Electrical Systems.

F. Division 31 and Section 22 0503 for Trenching, Backfilling and Compaction requirements.

G. Section 22 6801 for requirements of site utility systems including sanitary sewer, domestic water distribution system, and natural gas service.

H. All electrical work, regardless of voltage which is provided under Division 22 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

I. [Some work shown on the plumbing drawings and specified herein under Division 22 will be provided directly by the Owner and will not be included in the Contractor's Division 22 contract price, except the Contractor shall be required to fully cooperate and coordinate with Owner furnished Contractors and Agencies. Worked furnished directly by the Owner will include the following:

1.2 INDEX

1.3 CODES AND PERMITS

A. The plumbing work shall be performed in strict accordance with the applicable provisions of the International Building Code, 2015 Edition; the Uniform Plumbing Code, 2015 Edition; the Uniform Mechanical Code, 2015 Edition and the International Fire Code, 2015 Edition as adopted and interpreted by the State of New Mexico, City of Portales, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding plumbing systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas shall be paid for by the Contractor, unless otherwise specified herein. See Division 33 for all requirements associated with utility permits and fees, connections, extensions, meter pits, and meter sets.

C. The following lists some applicable codes and standards that shall be followed.

Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances.

National Electrical Manufacturer's Association Standards

National Electrical Code

Underwriters Laboratories, Inc. Standards

American National Standards Institute

American Society for Testing Materials Standards

Standards and requirements of local utility companies.

National Fire Protection Association Standards

American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

Occupational Safety and Health Act

Commercial and Industrial Insulation Standards (MICA)

American Gas Association

The American Society of Sanitary Engineering

National Sanitation Foundation

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all plumbing work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere. All refrigerants recovered from all systems shall be disposed of in compliance with these same regulations.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:
   a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
   b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
   c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 22, including but not limited to the following:

1. Piping materials, valves, insulation materials and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all plumbing equipment listed on equipment schedules, and in related construction documents.
2. Materials, certification, shop drawings, and other information as specified in the individual Division 22 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. The Contractor shall submit a maximum of seven (7) copies of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. One (1) copy of all submittals will be retained by the Engineer. The remaining copies will be returned to the Architect Additional sets of submittals, if required by the Contractor, shall be reproduced by the Contractor from the reviewed and marked sets returned to the Contractor.

H. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned

marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

I. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of plumbing and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

J. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

K. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

L. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Equipment rooms, and other spaces housing plumbing and equipment, etc.
2. Piping and chases.
3. Complete plumbing piping systems located within the building.
4. Layout of all plumbing equipment.

B. Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems, including piping, coordinated with HVAC plumbing, fire suppression and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the plumbing systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, sprinkler heads, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of plumbing devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8 inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the plumbing systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. [Installation of plumbing work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.]

1.11 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.12 PRIOR APPROVAL

A. Equipment manufacturers and service providers are listed within the specifications for the work specified in this division.

B. Manufacturers and service providers who are not listed in these specs, and who offer equivalent or superior products or services, are invited to submit for approval prior to bid (prior approval). Submit two copies. Requests for prior approval must:

1. Include the substitution request form at the end of this spec section.
2. Include technical data sufficient for the Engineer to generally assess appropriateness for this project.
3. Be submitted minimum ten days prior to the bid date in effect at the time of submission.
4. Comply with any additional requirements per specification Division 1.

C. Any additional prior approved alternate manufacturers and service providers will be published in an addendum prior to bid. Prior approval indicates that based on the information submitted it appears to the Engineer that the alternate might be capable of meeting the specifications and the design intent, and might be appropriate for the project. But prior approval does not guarantee this. Prior approved products and service providers must still go through the submittal process after award, and must still comply with the design intent and all specification requirements.

D. Please do not request prior approval for products and service providers that are not listed above. Instead, for those items alternate manufacturers and alternate service providers may be submitted after bid in accordance with the submittal process, provided they meet or exceed the specifications and the indicated design intent.

1.13 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

> "The Contractor guarantees that this installation is free from defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704", or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of plumbing equipment shall be provided with a full one (1) year parts and labor warranty, from the date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of plumbing equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCS, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 3000 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 22 0549, Plumbing and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.4 PAINTING

A. All finish painting of plumbing systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.5 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve. The Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Submitted drawings shall be neat and easily readable. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on

each valve installed under Division 22. Valves shall be listed by system, i.e. domestic cold water, hot water, chilled water etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 22 valve tags shall be coordinated with Division 21 and Division 23 valve tags for coordinated format between each Division.

C. Valve tags shall be coordinated with existing facility valve tags and Contractor shall obtain a copy of existing facility valve chart and provide updated valve chart to the Owner's Representative.

2.6 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping and duct systems installed and/or modified as part of this project shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

- Adjacent to each valve in piping system.
- At every point of entry and exit where piping passes through a wall.
- On each pipe riser and junction.
- At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
- Adjacent to all special fittings (regulating valves, etc.) in piping systems.
- At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow	- Hazardous Materials
Green	- Liquid Materials of Inherently Low Hazard
Blue	- Gaseous Materials of Inherently Low Hazard
Red	- Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"

2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

I. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Domestic Cold Water	White	Green
Domestic Hot Water	Black	Yellow
Domestic Hot Water Return	Black	Yellow
Industrial (non potable) Cold Water	White	Green
Roof Drain	White	Green
Sanitary Sewer	White	Green
Storm Sewer	White	Green

2.7 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the contract drawings.

2.8 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.9 EQUIPMENT TAGS

A. Furnish and install equipment identification tags for all items of PLUMBING equipment furnished and installed under Division 22. Equipment tags shall be a minimum of 3/32" thick laminated phenolic plastic.

2.10 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction, or Milcor institutional 10 gauge security/detention access door with welded joints, welded butt hinge, with detention type deadbolt lock and tamperproof screws.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the plumbing work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The plumbing drawings show the general arrangement of all piping, fixtures, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents, including but not limited to Division 21 Fire Suppression, Division 23 HVAC, and Division 26 Electrical shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural and Structural drawings shall take precedence over the plumbing, HVAC and fire suppression drawings. Install plumbing fixtures, floor drains, floor sinks, roof drains, etc. in locations as indicated on Architectural drawings. Because of the small scale of the plumbing, HVAC and fire suppression drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions

necessitate a rearrangement of piping, such departures and the reasons therefore shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior written approval. All changes shall be marked on the set of record drawings by the Contractor.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all plumbing equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within equipment rooms.

D. [The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 22 with the associated architectural, structural, and electrical work than is normally necessary for a more typical facility.]

E. The installation of all concealed plumbing systems shall be carefully arranged to fit within the available space without interference with adjacent structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed plumbing systems; access doors; piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the plumbing system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all plumbing work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the plumbing work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades 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 pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of plumbing, HVAC and fire suppression equipment within the

ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. Plumbing equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Architect. Equipment and materials shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with caps, with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gypboard sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Architect.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the plumbing work, fixtures and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect.

3.6 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the plumbing installation shall be provided by this Contractor.

3.7 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.8 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of plumbing equipment unless specifically deleted by the specifications or drawings.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all vibration isolators, anchor bolts, etc.

C. Contractor shall provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.9 EQUIPMENT FURNISHED UNDER OTHER SECTIONS OF THESE SPECIFICATIONS

A. Certain items of mechanical equipment as listed on the drawings and/or specifications will be furnished [under other sections of this specification for mechanical rough-in and connection under Division 22, including plumbing, domestic water and waste, cooling water, compressed air, etc. All required plumbing services, including connection of such services to equipment shall be provided under Division 22.

3.10 LUBRICATION

A. The Contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation and shall thoroughly grease the steel shafts to prevent corrosion. Bearings for items of plumbing equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

3.11 PRESSURE RELIEF DEVICES

A. Pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with Code requirements.

3.12 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.13 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

Domestic Water Heaters

3.14 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of plumbing equipment fixtures, faucets, etc., herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, bearings, shafts, etc.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

D. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the plumbing systems and equipment for a period of one (1) day of eight (8) hours. During this period, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

E. Film the instruction and training sessions submit two copies of the DVD.

F. Operational test shall be conducted by the Contractor with the assistance of the equipment manufacturer's representative or service technician. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.15 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.16 INTERRUPTING SERVICES

A. The Contractor shall coordinate the installation of all plumbing work onsite and within the building in order to minimize interference with the operation of existing building and onsite mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

3.17 ASBESTOS ABATEMENT

A. The Asbestos Abatement Contract Documents establish what existing plumbing piping and insulation is to be removed, what plumbing insulation is to be removed from existing plumbing equipment, and piping systems which are to remain. These documents shall be studied by the Division 22 Contractor. All existing plumbing piping, equipment for which asbestos contaminated insulation, tape have been removed under the abatement work and which are required to remain and be reused shall be provided with new insulation complying with the requirements of Section 22 0700.

3.18 CONSTRUCTION PHASING AND SCHEDULE

A. [All work furnished and installed under Division 22 of this Specification shall be provided in accordance with the project schedule and phase requirements [as described on the Architectural Drawings and Specifications.]

3.19 PLUMBING SYSTEM SHUTDOWN AND REACTIVATION

A. The Contractor shall shutdown existing facility plumbing equipment and piping systems as required for installation of the project plumbing construction work. As a part of the required work, the Contractor shall drain down the existing systems and after completion of new work and pressure testing of systems, the Contractor shall refill the systems and re-establish proper system circulation, remove all air from piping system and equipment, and place system in full and proper operation.

3.20 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Division 22 Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Division 22 Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

B. Prior to the "Final" observation visit, the attached "Final Observation Checklist" shall be completed by the Contractor. Any non-applicable items shall be marked "N/A." The completed form shall be submitted, indicating that all necessary items are complete and requesting a final observation within 10 days. The Contractor shall be notified of any uncompleted items within seven (7) days. A resubmittal of the form and a new final observation request by the Contractor is required if the form is returned and noted as incomplete.

END OF SECTION 220500

Project:_____ **Date Submitted:**_____

General Contractor:_____ **Date of Final Mechanical System:**_____

Mechanical Contractor:_____ **Observation Requested:**_____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST

(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

HVAC/PIPING

_____1. All plumbing fixtures are set, sealed and cleaned.

_____2. All domestic pipe systems are insulated.

_____3. All pipe systems are identified with specified labels and directional arrows.

_____4. Floor sinks and drain grates are cleaned and debris removed.

_____5. Valve tags are installed.

_____6. Special equipment (water softeners, water heaters, piping systems, etc.) have been checked and put into service.

_____7. Medical gas systems have been checked and certified.

_____8. Special piping systems have been cleaned and pressure tested.

_____	Process Piping	_____	Nitrogen
_____	Compressed Air	_____	Vacuum
_____	Natural Gas	_____	Argon
_____	Other	_____	Medical Gas
		_____	Other

_____9. Limestone chips have been installed in acid dilution sumps.

_____10. Plumbing/piping connections have been completed to Owner furnished equipment and equipment furnished by other Contractors/Sub-Contractors.

_____11. Exterior wall hydrants have been cleaned.

_____12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.

_____13. Drains and relief lines from plumbing equipment have been installed and secured in a proper manner.

_____14. All plumbing equipment and areas of equipment have been cleaned and debris removed.

_____15. All plumbing equipment required by the Specifications has been identified and/or numbered.

_____16. Domestic water systems sterilization has been completed.

_____17. Strainers/suction diffusers have been cleaned.

_____18. Backflow preventers have been tested.

_____19. Air has been vented from all systems.

_____20. Ethylene glycol system has been charged with correct mixture and tested.

_____21. Water systems have been cleaned (X) and pressure tested (P).

_____	Non-potable Water	_____	Domestic Hot Water
_____	Domestic Cold Water	_____	Acid Waste and Vent
_____	Sanitary Sewer & Vent	_____	Roof and Overflow Drains
_____	Other (list)		

_____22. PRV's have been adjusted (water, gasses).

PLUMBING EQUIPMENT

_____1. All pump shafts and couplings have been aligned.

_____2. Boilers and domestic water heaters have been fired and tested.

_____3. All plumbing equipment has been lubricated.

_____4. Plumbing equipment has been labeled in accordance with the specifications.

_____5. "HAZARDOUS AREA" signs installed where applicable.

_____6. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

GENERAL ITEMS

The following specified items have been submitted:

_____1. Record drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 22 0500).

_____4. Test kits furnished to Owner.

_____ Flow Measuring Devices

_____ Flow Balance Valves

_____ Flow Control Devices

_____5. Control schematics and sequence of operation.

_____6. Plumbing equipment and lubrication, valve, charts have been provided to Owner's Representative.

END CHECKLIST

DIVISION 22 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.**

PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

_____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐

   If YES, explain: _____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades? _____

   _____

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐

   If YES, explain: _____

   _____

7. Will substitution affect progress schedule? YES ☐ NO ☐

   If YES, explain: _____

   _____

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐

If YES, explain: _____

_____

9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____

Address: _____

Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted _____ Not Accepted: _____ Received too Late: _____
By: _____ Date: _____
Remarks: _____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 220501 - DEMOLITION FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work for Plumbing.

B. Division 1 for Cutting and Patching.

1.3 SCOPE OF WORK

A. The terms "demolish" and “remove” shall mean disconnect, cart away, and dispose of off site. Components to be demolished or removed include all materials, equipment, building construction and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.

B. Except as specifically noted, asbestos abatement will be by others, and is not included in this contract. Advise Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.

C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0501, for applicable requirements.

END OF SECTION 220501

SECTION 220503 - TRENCHING AND BACKFILLING FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 22.

B. The Contractor shall provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplementary Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 TRENCHING AND BACKFILLING

A. General Excavation: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not required or suitable for backfill shall be removed and wasted. Berming and grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as required for the protection of the work and for the safety of personnel.

B. Trench Excavation: Trenches shall be of adequate width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable and safe for workmen. The bottom of the trenches shall be accurately graded and bedded to provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and bedded in order that the pipe rests upon the prepared bottom for as nearly its full length as practicable. Care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated on the drawings or specified. Overdepths in the rock and common excavation shall be backfilled with coarse sand, fine gravel, or otherwise suitable material. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable materials, as hereinafter specified.

C. The Contractor shall move trucks and equipment on prescribed roads and keep the roads free from mud, dirt and spillage.

D. If additional material is needed for fill on the project, it shall be furnished by the Contractor.

E. Bracing and Bulkheading: In all excavation work the Contractor shall provide necessary underpinning, bracing, or bulkheading to safeguard the work, the present structures, workmen, the public, and the property, and shall assume all responsibility in connection therewith.

F. Backfilling: The trenches shall not be backfilled until all required pressure tests are performed and until the utilities as installed conform to the requirements specified. The trenches shall be carefully backfilled with materials approved for backfilling; free from large clods of earth or stones. The entire depth of trench shall be backfilled in layers, and each layer shall be spread evenly, wetted to optimum moisture and thoroughly mixed to uniform consistency and compacted to the required maximum density obtainable as the same soil, as determined by ASTM D698.

G. All imported fill required under this section will be furnished by the Contractor. Imported fill will be base course material approved for use by the State Highway Department.

H. Fill material shall be free from trash, lumber or any type of debris which may be detrimental to producing the required density in the fill.

I. The earth beneath all sidewalks and concrete slabs shall be backfilled and compacted to at least 8" below any gravel or sub-base material before the placement of gravel or other base material and shall be coordinated with requirements contained within Division 33.

J. All piping not encased in concrete shall be bedded in sand or fine gravel, without rocks or other foreign material. Bedding material shall be placed around the pipe in accordance with manufacturer’s recommendations. The bedding material shall be distributed around pipe to assure full consolidation.

K. In grass and planted areas, the Contractor shall backfill his excavation to approximately 8" below finished grade. Contractor shall coordinate backfill requirements contained in Division 33.

L. The Contractor shall protect from damage all existing underground utilities and utility tunnels indicated on the Contract Drawings or field located by underground utility locator service by the Owner prior to excavation operations. Any damage to such existing utilities or utility tunnels shall be repaired by the Contractor without additional costs to the Owner.

M. Provide density test for trench, backfill in accordance with Division 33 requirements.

END OF SECTION 220503

SECTION 220504 - PIPE AND PIPE FITTINGS FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

END OF SECTION 220504

SECTION 220505 - PIPING SPECIALTIES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0523, Valves for Plumbing.

D. Section 22 0700, Plumbing Insulation.

E. Section 22 0549, Plumbing and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. The Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, Piping Specialties.

PART 3 - EXECUTION

See Division 23, Section 23 0505, Piping Specialties.

END OF SECTION 220505

SECTION 220523 - VALVES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Division 21 for Fire Suppression System.

D. Division 22 for Plumbing.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Ball valves shall be utilized in lieu of gate valves and globe valves for all plumbing systems for sizes 2" and smaller.

D. All valves furnish under Division 22 and 23 of the same type shall be products of a single manufacturer unless otherwise approved by Owner's Representative.

E. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

PART 2 - PRODUCTS

See Division 23, Section 23 0523 - Valves, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0523 - Valves, for applicable requirements.

END OF SECTION 220523

SECTION 220549 - PLUMBING AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 23 0900, Facility Management System.

C. Division 26 for Electrical.

D. Division 28 for Electronic Safety and Security.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 22 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 22	Div. 22	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div.23
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 23
Variable Frequency Drives (VFD's)		Div. 22	Div. 22	Div. 26	Div. 23
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 22	Div. 22	Div. 26	Div. 23
Boilers & Domestic Water Heaters		Div. 22	Div. 22	Div. 26	Div. 23
Pressure Booster Pump Systems		Div. 22	Div. 22	Div. 26	Div. 23
Water Softeners & Other Process Water Equipment		Div. 22	Div. 22	Div. 26	N/A
Facility Management System (FMS) for Automatic Control and/or Monitoring of Plumbing System & Equipment	(2)	Div. 23	Div. 23	Div. 26	Div. 23
Medical Gas System - Alarm Panels, Sensors, Pressure Switches	(3)	Div. 22	Div. 22	Div. 26	Div. 22

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall coordinate with Division 23, FMS Contractor as required to provide 120 VAC power to each mechanical space and the central plant as necessary for the FMS and as shown on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 22 indicates the plumbing contractor or their designated representative including equipment suppliers, sub-contractors, etc.

END OF SECTION 220549

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. The Midwest Insulation Contractors Association and Industrial Insulation Standards, Latest Edition, shall be utilized as a standard for the work provided under this specification.

C. Materials shall conform to applicable ASTM standards.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

1.3 SCOPE

A. All condensate pipe and fittings, domestic hot water pipe including circulating hot water, interior roof drains including roof drain bowls, interior overflow roof drains including overflow roof drain bowls, domestic cold water including non-potable water piping, water piping located outdoors exposed to ambient freezing conditions.

B. Equipment covering, including domestic water heater stacks and breeching.

C. Plastic Piping Systems.

1.4 FITTINGS

A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.

B. Unions, flanges and valves on hot water, will not require insulation.

1.5 TESTING

A. All piping shall be tested in accordance with the applicable Specification Sections, before any insulation is applied.

PART 2 - PRODUCTS

2.1 INSULATION

A. Insulation shall be as manufactured by Owens-Corning Fiberglas, Knauf, CertainTeed, Johns Manville, or Armstrong, or equivalent, and shall be equal to that specified below. Insulation and all materials on the interior and exterior surfaces of ducts, pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. All insulation materials used for valves and fittings shall have the same ratings as the pipe insulation. Information must be submitted by means of manufacturer's literature showing that the proposed materials conform to above specification without exception.

B. Fiberglass pipe insulation shall be rigid molded and non-combustible with 'K' factor of 0.23 at 75°F. Jacket shall be all service (ASJ) vapor barrier jacket with white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self sealing longitudinal laps and butt strips. Johns Manville 'Micro-Lok' or equivalent.

C. Hydros Calcium Silicate insulation shall be rigid molded, non-combustible per ASTME 136, conforming to ASTM 533, asbestos-free with 'K' factor of 0.40 at 300°F., maximum service temperature 1200°F., compression strength (block) minimum of 200 PSI to produce 5% compression at 1-1/2" thickness. Johns Manville 'Thermo-12 Gold' or equivalent.

D. Fiberglass rigid board insulation for equipment shall conform to ASTM C612 with 'K' factor of 0.23 at 75°F, R=8.0 minimum, 3.0 pound per cubic foot density. Provide vapor barrier jacket (FSK) with aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and outward clinched expanded staples and vapor barrier mastic. Johns Manville 'Spin-Glas' or equivalent.

E. Elastomeric foam insulation for piping and equipment shall be flexible, cellular, molded or sheet, conforming to ASTM C534, with 'K' factor of 0.28 at 75°F., maximum service temperature of 220°F., maximum flame spread rating of 25 and maximum smoke development rating of 50 (3/4" thickness and less). Connections shall be made using manufacturer's approved waterproof vapor barrier retarder adhesive. Provide outdoor U.V. protective coating on all insulation exposed to ambient conditions.

2.2 FITTINGS

A. Valves and fittings, where required to be insulated, shall be covered with the same insulation material and thickness as specified for the pipe insulation and finished with PVC covers.

B. Valves and fittings with systems specified to be covered with metal or canvas, or polyvinyl chloride (PVC) jacket shall be covered with material to match piping system jacketing.

C. Polyvinyl chloride (PVC) preformed fitting covers with fiberglass inserts shall be used on valves and fittings, except where metal or canvas jacket is required for piping system. PVC fitting covers shall be Zeston 2000 or equivalent, gloss white and shall have a composite fire and smoke hazard rating not exceeding; flame spread - 25; smoke development - 50.

Connections shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.3 METAL JACKETING

A. Metal jacket shall be 0.010-inch smooth Type 304 stainless steel, smooth. Provide moisture barrier lining for service temperatures 60°F and less, except where applied over insulation with All Service (ASJ) vapor barrier jacket. Stainless steel jacket shall be installed where specified herein or otherwise indicated on the drawings.

B. Metal jacket shall be 0.016-inch smooth aluminum. Provide moisture barrier lining for service temperatures 60°F and less except where applied over insulation with All Service Jacket (ASJ) vapor barrier jacket. Aluminum jacketing shall be installed where specified herein or otherwise indicated on the drawings.

2.4 PVC JACKETING

A. PVC jacketing shall be Zeston 2000 or equivalent, gloss white, 0.020 inch thickness, minimum, and shall have a composite fire and smoke hazard rating not exceeding; flame spread -25; smoke development -50. Connection shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.5 PIPE HANGERS AND SUPPORTS

A. See Specification Section 22 0504 for requirements associated with hangers and supports for piping systems.

B. All insulated piping systems shall be provided with individual hangers sized to encircle the insulation. Hangers for domestic cold water and roof drains may be installed under the insulation, provided that the vapor barrier system for cold piping and the hanger rods are protected from the formation of condensation by application of a heavy coating of vapor barrier mastic material.

C. Insulated piping supported by means of trapeze hangers or roller type hangers shall not rest directly on the hanger or support.

D. The insulation at hangers, trapezes and supports shall be protected by means of galvanized steel insulation half diameter support shields. Provide insulation insert between support shield and piping for piping size 1-1/2" and larger. Insulation inserts shall be heavy density calcium silicate molded insulation. Insulation inserts shall be the following minimum lengths. Factory fabricated thermal pipe shield as manufactured by Pipe Shields, Inc., and specified in Section 22 0504, may be used at Contractor's option.

Pipe Size, In.	Insert Length
1-1/2" to 2-1/2"	10" Long
3" to 6"	12" Long
8" to 10"	16" Long
12" and larger	22" Long

2.6 PIPE SLEEVES

A. See Specification Section 22 0504 for requirements associated with pipe sleeves for piping penetrations for building walls and frames.

B. Pipe sleeves shall be provided at penetrations through concrete and masonry construction and at fire rated and smoke rated walls and penetrations when required to comply with UL approved penetration assembly. Insulated piping passing through fire walls and smoke walls shall be provided with UL approved fire safing insulation to match the required insulation thickness and the space between the piping penetration and the adjacent wall construction shall be sealed air tight with UL approved fireproof caulking material. Pipe penetration arrangement and installation requirements shall match the applicable UL approved penetration assembly details.

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER PIPING

A. Domestic hot water piping with operating temperatures of 140^{o}F and less, including recirculating hot water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be finished with PVC fitting covers.

B. Insulation thickness for domestic and service water systems operating in excess of 140^{o}F, shall be 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ) for piping 3/4" through 3" size and 1-1/2" thick for piping 4" and larger. Fittings shall be finished with PVC fitting covers.

C. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.2 DOMESTIC COLD WATER AND ROOF DRAINS

A. Domestic cold water piping including non-potable water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Services Jacket (ASJ). Fittings shall be finished with PVC fitting covers.

B. Roof drain bowls and horizontal roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

C. Overflow roof drain bowls and horizontal overflow roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

D. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.3 HANDICAP LAVATORY AND SINKS

A. Domestic hot and cold water piping and P-traps exposed below handicapped lavatories and sinks shall be insulated with HANDI LAV-GUARD insulation kits which satisfy ANSI A117.1 requirements. Insulation shall have a flexible vinyl finish which protects against burning and cushions impact.

B. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches.

3.4 PLASTIC PIPING SYSTEMS

A. Plastic piping systems, including but not limited to polypropylene/CPVC, RO/DI piping, acid waste, vent piping and PVC piping, installed within building return air plenums shall be insulated with 1/2" thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be insulated with preformed insulation fittings or, where preformed fittings are unavailable, neatly insulated with fiberglass duct wrap with white vinyl jacket.

B. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.5 METAL JACKETING

A. Metal jacketing shall be installed on all field insulated plumbing equipment and on plumbing piping systems [exposed within the mechanical equipment spaces, that are installed exposed below 8 feet above the floor, where exposed to physical damage, on outdoor insulated piping, inside accessible tunnels, and where noted on the drawings.

B. The jacketing shall be applied with joints overlapped 2" and located to shed water. Joints and seams shall be caulked with an approved weatherproof caulking when located outdoors. The insulation shall be banded 12" on centers or screwed in place 3" on centers.

C. Fittings and valves shall have insulation covered with metal jacket, as specified herein. Fittings and valves on exterior piping and ductwork shall be covered with metal jacketing to match pipe and duct covers. PVC fitting covers, painted to match adjacent metal jacket, may be used on interior pipes and ducts.

3.6 PVC JACKETING

A. PVC jacketing shall be installed on all field insulated plumbing equipment and on all piping systems exposed within the mechanical equipment spaces, that are installed below 8 feet above the floor, where exposed to physical damage, inside accessible tunnels, and where noted on the drawings and specifications, except where metal or canvas jacketing is required.

B. Jacketing shall be secured in place in an approved manner by means of tacks and pressure sensitive tape.

C. Fittings and valves shall have insulation covered with PVC pre-molded PVC fittings to match jacketing, as specified below.

D. PVC jacketing shall not be permitted for use on exterior piping systems.

3.7 TERMINATION OF INSULATION

A. The termination of all insulation on pipes, at uninsulated valve connections, or unions, flexible connections, etc., shall be beveled and finished.

3.8 FACTORY INSULATED EQUIPMENT

A. Domestic water heaters and other equipment as specified in the equipment schedules on the drawings shall be factory insulated.

3.9 VICTAULIC COUPLINGS

A. Where Victaulic type couplings or similar piping systems are used, all couplings shall be insulated with insulation materials and thickness equal to the piping system. Insulation of couplings shall be as specified herein for fittings.

END OF SECTION 220700

SECTION 221100 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead. Solder shall be 95/5 tin antimony, alloy Sb5, conforming to FS QQ-S-571 and NSF 61.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 22 0700, Plumbing Insulation.

F. Section 22 6801, Onsite Utilities, Plumbing.

G. Section 23 0900, Facility Management System.

H. Section 22 6801 for Outside Utilities.

1.3 SCOPE

A. A complete domestic cold water, hot water, recirculating hot water, non-potable water and make-up water system including water heaters, pumps, thermal expansion tanks, water softeners, meters, backflow protection, shock absorbers, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

PART 2 - PRODUCTS

2.1 PIPING

A. Domestic water piping including non-potable water piping, below grade or slab-on-grade shall be Type L soft copper, ASTM B88. Copper piping 2" and smaller shall be soft tubing and 2-1/2" thru 4" shall be either soft tubing or hard pipe. Domestic water piping 6" and larger below grade within the building and to a point approximately 5'-0" from the building shall be ductile iron pressure pipe, minimum 150 PSIG working pressure with mechanical joints. Wrap all underground copper pipe and fittings with minimum 20 mil polyethylene with minimum 50% overlay, provide for taping.

B. Domestic water piping including non-potable water piping above grade within the building 4" and smaller shall be Type L hard drawn copper, ASTM B88. Domestic water piping including non-potable water piping larger than 4" shall be [either] copper as specified herein or galvanized steel, ASTM A53 or A120, standard weight, Schedule 40 or flanged ductile iron pipe.

C. Proper insulating fittings, as specified in Section 22 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

A. Fittings for copper piping shall be wrought copper or cast brass conforming to ANSI B16.22 and B16.23, with 95-5 solder joints, as specified in Section 22 0504.

B. Mechanically formed tee connections and couplings for copper piping system as specified in Section 22 0504, may be utilized where approved.

C. Fittings for galvanized steel pipe shall be screwed Class 150, standard galvanized malleable iron conforming to ANSI B16.3 or Victaulic or equivalent mechanical pipe couplings as specified in Section 22 0505 and furnished with hot dipped galvanized coating for use with grooved piping system and approved for potable water systems.

D. Fittings for ductile iron pipe shall be flanged or mechanical joint conforming to ANSI/AWWA C110 and C111, Class 250 minimum, cement lined, with bituminous coating.

2.3 JOINTS

A. Joints in copper piping system shall be made using approved "lead-free" solder and flux as described herein and approved by all applicable codes and regulations. Surfaces to be soldered shall be cleaned bright by manual or mechanical means.

B. All joints shall be properly fluxed with a non-corrosive "lead-free" type flux manufactured to approved standards, Federal Specification QQ-S-517. Joints for copper piping systems for cold water 3" and smaller and hot water 2" and smaller shall be made using composition 95-5 tin-antimony solder. Composition 15% silver solder shall be used for all other piping sizes and for all underground joints.

2.4 SHOCK ABSORBERS

A. Furnish and install factory sealed shock absorbers conforming to Federal Specification WW-P-541 at locations shown on the drawings and/or as outlined by Plumbing Drainage Institute Standard WH-201. Josam, Precision, Jay R. Smith, Wade, Watts, Zurn or equivalent.

2.5 DOMESTIC HOT WATER GENERATING EQUIPMENT

A. Water heaters and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings. Natural gas fired or electric domestic water heaters shall be as manufactured by Bock, Bradford-White, Lochinvar, P.V.I., Ruud, Rheem, A.O. Smith, State, or equivalent.

B. Electric instantaneous water heaters shall be by Chronomite, Eemax, Hubbell, Keltech, Rheem, Stiebel Eltron, State, or equivalent.

C. Furnish and install approved expansion tank on cold water make-up supply to hot water generating equipment as recommended by manufacturer or as shown on the drawings and specified in the plumbing equipment and fixture schedule on the drawings, Amtrol, Wilkins, or approved equal.

D. The Contractor shall provide the services of a qualified factory-trained representative to supervise hot water generation system start-up and instruct the Owner's operating personnel for a minimum of eight (8) hours. A full one (1) year service warranty, including all parts and labor, shall be provided by the Contractor.

E. Natural gas fired domestic hot water boilers and water heater combustion flues, stack, breeching, and combustion air louvers, ducts, etc., shall be provided under Division 23.

2.6 VALVES

A. Valves other than automatic control valves are specified in Section 22 0523, Valves.

B. Automatic control valves shall be as specified in Section 23 0900, Facility Management System, except for automatic control valves furnished as a part of equipment packages, including hot water generating equipment, as specified on the equipment schedule.

2.7 PUMPS

A. Pumps shall be of the type and capacity listed in the equipment schedule. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All base mounted pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping. All pumps for potable water applications shall have bronze or stainless steel body and trim.

B. Domestic water inline re-circulating pumps shall be as specified on the drawings and as manufactured by Armstrong, Bell & Gossett, Taco, Thrush, or equivalent.

2.8 WATER METER

A. All costs, fees, and permits required for the installation of the water meter shall be secured and paid for by the Contractor unless otherwise indicated.

B. Water meters shall be installed by the Contractor in accordance with the information shown on the drawings and in the Plumbing Fixture Schedule on the drawings.

C. See Section 23 0900, Facility Management System, for plumbing, meters and instrumentation.

2.9 BACKFLOW PROTECTION

A. All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system.

B. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.

C. Reduced pressure backflow preventer assembly shall be furnished and installed by the Contractor. Backflow preventer size and arrangement shall be as indicated on the drawings, and shall be as manufactured by Febco, Hersey, Beeco, Watts, Wilkins, or equivalent. All costs, fees, and permits required shall be secured and paid for by the Contractor, unless otherwise indicated.

D. See Section 22 6801 for backflow protection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for plumbing.

B. Insulating Fittings: Insulating unions shall be furnished and installed at all connections between dissimilar metals.

C. Valves: Each water service main, branch main and branch to a group of two or more fixtures shall be valved. Stop valves shall be as specified under fixtures.

D. Flexible Connections: If the Contractor uses a pipe material other than copper to connect to the City water main, provide mechanical joints at the connection point and also either a swing joint or expansion joint at a point 5 ft. outside the building to prevent failure of piping caused by differential settling of building and piping systems. The expansion joint material shall be suitable for domestic water usage and compatible with the sterilization chemicals.

3.2 STERILIZATION

A. All new water piping shall be charged with a chlorine solution containing not less than 50 PPM available chlorine. The solution shall remain in the piping for a period of 24 hours, during which time valves shall be opened and closed to permit a small flow of the solution. At the end of 24 hours, the solution shall be tested and must contain a residual of at least 5-10 PPM chlorine. The system shall then be drained and flushed to provide satisfactory potable water before final connection is made to the existing distribution system.

B. The Contractor shall submit a sample of the water, after sterilization and flushing for testing by an approved laboratory. A copy of the acceptable test report shall be submitted to the Architect prior to substantial completion.

3.3 BACKFLOW PROTECTION

A. Protection: All plumbing fixtures, faucets with hose connections, and all other equipment having plumbing connections shall have their water supplies protected against back-siphonage.

B. Testing: Arrange for testing backflow devices as required by the local health authorities.

3.4 TESTS

A. All water piping, hot and cold, shall be made tight under a hydrostatic test pressure of 150 lbs. per square inch and maintained without pressure loss for a minimum of four (4) hours. No caulking of joints will be permitted. Any joint found to leak under this test shall be broken, remade and a new test applied.

END OF SECTION 221100

SECTION 221123 - FACILITY NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Supplemental General Conditions.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 23 0900, Facility Management System.

F. Division 22 for onsite utilities.

1.3 SCOPE

A. Complete building natural gas piping system including meters, regulators, and miscellaneous accessories. This section shall include all work within the building and to a point approximately 5'-0" outside the building, or as otherwise indicated.

PART 2 - PRODUCTS

2.1 PIPING

A. Above ground pipe used for the installation, extension, alteration, and/or repair of any gas piping system shall be black steel pipe ASTM A53 Grade A or B, ERW or BW, standard wall, Schedule 40.

2.2 FITTINGS

A. Fittings for steel piping 2" and smaller shall be either screwed or welded. Screwed fittings shall be Class 150 standard black malleable iron conforming to ANSI B16.3. Weld fittings

shall be either standard weight steel butt-weld fittings conforming to ANSI B16.9, or forged steel socket-weld fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.

B. Fittings for steel piping 2-1/2" and larger shall be standard weight steel butt-weld fittings conforming to ANSI B16.9.

2.3 VALVES

A. Valves shall be as specified in Section 22 0523, Valves for Plumbing.

B. Valves used in conjunction with gas piping shall be approved for the required service.

2.4 GAS METERS

A. Natural gas meters shall be furnished and installed by the natural gas utility company, unless otherwise indicated on the drawings. All required permits and fees shall be secured and paid for by the Contractor in accordance with Section 22 0500. Gas meter shall be the type and capacity required for the application and shall be located as indicated on the drawings and in accordance with utility company requirements and applicable codes and ordinances.

B. See Division 22, Section 22 6801, for natural gas meters.

C. Natural gas meters shall be furnished and installed by the Contractor in accordance with the information shown on the drawings and in the plumbing equipment and fixture schedule on the drawings.

D. See Section 23 0900, Facility Management System, for meters and instrumentation.

E. All natural gas meters shall be preceded by a main gas supply shut-off valve serviceable and accessible outside the building.

2.5 NATURAL GAS REGULATOR

A. Natural gas regulator shall be furnished and installed with the gas meter by the utility company, set for the required gas leaving pressure shown on the drawings.

B. Natural gas appliance and equipment regulators for all gas fired equipment furnished and installed under Division 23 and for natural gas fired equipment furnished by the Owner and/or under other sections of this specification shall be furnished by the equipment manufacturer or supplier and sized for the system inlet pressure and the required appliance operating pressure.

C. See Division 22, Section 22 6801, for natural gas meter and regulator.

D. Natural gas regulators, as specified and shown on the drawings, shall be furnished and installed by the Contractor.

2.6 PIPING SUPPORTS

A. Natural gas piping installed on the building roof shall be supported by means of piping supports, especially designed to absorb thermal expansion and contraction of piping installed on built up and single ply membrane roofs. Wood blocks are not acceptable. Four inch and smaller gas piping shall be mounted on Erico Pyramid pipe supports or equivalent, pipe supports with a total weight not to exceed 100 pounds per pipe stand. Larger piping, and all piping requiring roller bearing action for pipe expansion, shall be mounted on Erico Pyramid RPS-H or equivalent, with a total weight not to exceed 1500 pounds per pipe collar support. Pipe support spacing shall be as recommended by manufacturer and as required by Code.

B. Piping hangers and supports shall be in accordance with Section 22 0504, Pipe and Pipe Fittings for Plumbing.

2.7 PAINTING

A. All new and existing natural gas piping installed outside the building exposed to the weather and/or exposed to view shall be field painted in accordance with the painting sections of this specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including Uniform Plumbing Code and Uniform Mechanical Code, and NFPA No. 54, National Fuel Gas code.

C. No gas piping shall be installed in or on the ground under any building or structure, and all exposed gas piping shall be at least 6-inches above grade. Ferrous gas piping installed underground in exterior locations shall be protected for corrosion as specified herein and in Section 22 0504, Pipe and Pipe Fittings for Plumbing.

D. Gas piping supplying the building or facility shall be provided with a shut-off valve located outside the building and readily accessible. Where gas piping supplies multiple buildings or facilities, each building shall be provided with a shut-off valve as described herein.

3.2 EQUIPMENT AND APPLIANCE CONNECTIONS

A. All gas fired equipment and appliances shall be connected to the gas piping system in an approved manner and shall be furnished with a shut-off valve installed ahead of the unit. Connections shall in no case be less than the unit inlet connection size and shall be rigidly connected, except as otherwise shown on the drawings and allowed by codes and regulations.

3.3 DRIPS

A. Accessible capped drip pockets shall be furnished at low points in piping system, connections to appliances and equipment, and other locations where condensation may tend to collect.

3.4 VENTS

A. All gas regulators and other required devices installed within the building shall be vented to the outside of the building in accordance with manufacturer's requirements, codes, and regulations.

3.5 TESTS

A. All gas piping shall be pressure tested using air, CO2, or nitrogen in accordance with the applicable codes and regulations, including Uniform Plumbing and Mechanical Code as adopted and interpreted by the City of Portales and State of New Mexico, and NFPA No. 54.

END OF SECTION 221123

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Special Provisions.

B. Furnish and install all concrete, grout, and other required materials to fill all blockouts and/or sleeves left open for this Contractor's convenience or for the installation of this work.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0700, Plumbing Insulation.

D. Section 22 6801 for Onsite Utilities Plumbing.

E. Section 23 0900, Facility Management System.

1.3 SCOPE

A. Complete soil, waste, and vent system, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Plumbing equipment drains.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. General: Piping Materials listed below shall bear the label of the testing agency/standard specified.

B. Soil, waste and vent pipe and fittings below slab:
   1. Hubless cast iron, coated on both sides, conforming to ASTM A 888 and CISPI 301.
   2. Service weight, hub-and-spigot cast iron, coated on both sides, conforming to ASTM A 74.

3. Schedule 40, solid wall, polyvinyl chloride (PVC) with a cell class of 12454 or 12364 per ASTM D 1784, iron pipe size (IPS) conforming to ASTM 1785 and ASTM D 2665. Cast iron pipe and fittings shall be used on all waste piping subject to waste water temperatures that exceed 120° F.

C. Soil, waste and vent pipe and fittings above grade:
   1. Hubless cast iron, coated on both sides, conforming to ASTM A 888 and CISPI 301.
   2. Service weight, hub-and-spigot cast iron, coated on both sides, conforming to ASTM A 74.
   3. Schedule 40, solid wall, polyvinyl chloride (PVC) with a cell class of 12454 or 12364 per ASTM D 1784, iron pipe size (IPS) conforming to ASTM 1785 and ASTM D 2665. Cast iron pipe and fittings shall be used on all waste piping subject to waste water temperatures that exceed 120° F.

2.2 JOINTS

A. Hubless cast iron: Heavy duty, shielded, minimum (4) band couplings consisting of elastomeric gasket conforming to ASTM C 564 and 0.008" thick type 304 stainless steel shield.

B. Hub-and-spigot cast iron: Double seal compression type rubber gaskets conforming to ASTM C 564, with adhesive type lubricant, Tyler "LUBRI/FAST" or equivalent.

C. PVC: Two step primer/solvent cement procedure per ASTM D 2855. Adhesive primer shall conform to ASTM F 656 and solvent cement shall conform to ASTM D 2564.

2.3 PLUMBING EQUIPMENT DRAINS

A. Equipment drain lines shall be either Schedule 40 galvanized steel pipe with galvanized malleable iron fittings or Type L copper tubing with wrought solder fittings. Provide a dielectric union at all connections between ferrous to copper materials.

2.4 DRAINS

A. Floor drains, floor sinks, and interceptors shall be Josam, Rockford, Jay R. Smith, Wade, Watts, Zurn, Mifab, or equivalent, as specified on the drawings, and compatible with the required piping systems.

B. Non water-based trap seal maintenance devices by Jay R. Smith Mfg. Co., Liquidbreaker – The Green Drain, SureSeal, and TrapGuard as specified on the drawings are approved.

2.5 TRAPS AND TAILPIECES

A. Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal to metal or metal to plastic type as required for the application. Outlet shall be threaded or socket for

solder joint connection as required by the application. Tailpiece shall be copper-alloy to match P-trap. Furnish cast brass wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated. Underground P-traps shall be coated cast iron or plastic as required by the application.

B. Traps and associated trim shall be furnished by the plumbing fixture manufacturer as specified in Section 22 4000 and in the Fixture Schedule on the drawings, or shall be as manufactured by Dearborn, EBC, McGuire, T & S Brass, or equivalent.

C. Traps for acid resistant piping systems shall be compatible material for required piping system.

2.6 CLEANOUTS

A. Cleanouts shall be as manufactured by Zurn, Jay R. Smith, Watts, Wade, or Josam, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter-bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and finished flush with the floor. Heavy duty cleanouts shall be Zurn Z-1474, with integral anchor flanges. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T-pattern, 90 degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z-1460-8 with polished stainless steel or chrome plated metal cover.

B. Cleanouts for acid resistant piping system shall be compatible material for the required piping system.

C. Install cover flush with grade (outside) to avoid tripping hazard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties.

B. All soil, waste, and vent piping shall be properly graded and installed in strict accordance with all applicable codes and requirements.

C. Make all changes in direction of drainage piping by use of 45 degree wyes, long turn tee wyes, long sweep quarter bends, sixth, eighth or sixteenth bends. Short turn sanitary tees permissible on horizontal to vertical where space conditions require.

3.2 FLASHINGS

A. Flashing for piping through built-up roofing with lead flashing, weight of not less than four pounds per square foot, extending at least 12" in all directions under roofing and up pipe. Cap flash pipe and turn down inside 1" approximately. Run all pipes extending through roof prior to roof installation. Flashing shall be two-piece type, base and cap flashing.

B. Vinyl Flashing: As an option to lead flashing in vents through roof, the Contractor may use vinyl flashing, 20 mil thickness, ASTM C689-62 tear strength, 0.14 #/Ft. equal to Pasco Manufacturing Co., or equivalent. The flashing shall be installed in accordance with the manufacturer's recommendations.

C. Flash piping through the membrane roofing systems with premolded pipe seal elastomeric flashing and sealants that are compatible with EPDM single ply membrane. The flashing material and installation procedure shall be in accordance with the roofing manufacturer's recommendations.

3.3 DRAINS

A. All floor drains and floor sinks shall be installed with grates square with building lines and with the top of grates installed level with adjacent finished floor.

B. The Contractor shall extend drain lines from all equipment requiring drainage, relief valves, and drain pans to the nearest floor drain or floor sink, and shall terminate indirectly with a minimum clearance of one (1) inch or as otherwise required by applicable codes and standards. Relief valve drain lines shall be extended to the nearest floor drain and shall be equal in size to relief valve outlet port.

3.4 PVC PIPING SYSTEMS

A. Installation of PVC piping systems within the building shall be in accordance with all applicable plumbing and building codes and ordinances. No exposed piping or fittings shall be installed within the building ceiling space and return air plenums unless the material complies with all code requirements, including required fire and smoke ratings, or is properly protected to meet the intent of the code. Penetrations of fire rated barriers shall be provided with [acid resistant] cast iron as specified in this section, or as otherwise approved and accepted by the applicable code authority. Piping above grade shall be installed with uniform slope and shall be properly supported to avoid sagging or bending of horizontal or vertical lines due to insufficient support or thermal expansion/contraction. All piping shall be supported and installed in strict accordance with manufacturer's recommendations.

B. PVC pipe and fittings exposed within building return air plenums shall be covered with an approved insulation material, as specified in Section 22 0700.

3.5 TESTS

A. The sanitary soil waste and vent system and condensate drain system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system

water test shall be applied to the drainage and vent systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.

B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than ten (10) feet of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

END OF SECTION 221316

SECTION 224000 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 1100, Domestic Water Piping.

D. Section 22 1316, Sanitary Waste and Vent Piping.

PART 2 - PRODUCTS

2.1 FIXTURES AND EQUIPMENT

A. Vitreous china and enameled cast iron fixtures by American Standard, Kohler, Sloan, Zurn, Mansfield, Toto, or equivalent as listed and described in the plumbing fixture schedule on the drawings. All vitreous china and enameled cast iron fixtures shall be white, unless otherwise indicated on the drawings. The material used for plumbing fixtures shall be of non-absorptive, acid-resistant vitreous china, enameled cast iron or stainless steel, and free from all imperfections. Each water service main, branch main, riser and branch to a group of fixtures shall be valved or as otherwise shown on the drawings to provide more stringent requirements. Stop valves shall be provided at each fixture. One piece chrome plated escutcheons shall be installed on all water piping and trap connections at walls or base cabinets. All exposed connecting piping and material shall be chrome plated.

B. Handicap accessible lavatories and counter mounted sinks shall have exposed supply and waste services insulated with rigid, molded insulation kits as manufactured by T.C.I. "Skal-Gard", Brocar

"Trap Wrap", True-Bro "Handi Lav-Guard", McGuire "Prowrap", or equivalent. Provide off-set tail piece fittings on all handicap accessible laboratories and sinks as required.

C. Flush valves shall be low water consumption type as specified on drawings. Valves shall be diaphragm or piston type, with metal oscillating non-hold open handle, screw driver back check angle stop assembly with cap, adjustable tailpiece, vacuum breaker flush connection, and spud couplings as required for wall and fixture rough-in. Exposed flush valves shall be fully chrome plated, with chrome plated supply pipe cover. Furnish special trim for concealed installation with push-button and/or electronic sensor operation as specified in the Plumbing Fixture Schedule on the drawings. Electronic and battery operated flush valves shall be furnished with chrome plated metal cover. Flush valves shall be American Standard, Delany, Delta, Sloan Regal, Sloan Royal, Zurn, Toto, or equivalent.

D. Closet seats shall be furnished for water closets as specified on the Plumbing Fixture Schedule on the drawings. Closet seats shall be white unless otherwise required to match water closet. All closet seats shall be of smooth non-absorbent material and shall be properly sized for the water closet bowl type. All closet seats for fixtures for public use shall be open-front type without cover. Water closet seats provided for handicapped fixtures shall meet all handicapped requirements. Hinges, posts, nuts, and pintles shall be of a 300 series stainless steel construction. Water closet seats shall be furnished by the plumbing fixture manufacturer as specified on the Fixture Schedule on the drawings, or shall be as manufactured by Bemis, Beneke, Centoco, Church, Jones Stephens, Olsonite, Sperzel, or equivalent.

E. Floor mounted mop sinks shall be as specified on the Plumbing Fixture Schedule on the drawings, molded stone or terrazzo, size and arrangement as shown on the drawings, as manufactured by Acorn, Centoco, Designer's Choice, Fiat, Mustee, Stern-Williams, Zurn, or equivalent. All mop sink faucets shall be equipped with inlet checkstops.

F. Stainless steel sinks shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Kohler, American Standard, Elkay, Just, Advance Tabco, Moen, Intersan, or equivalent. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches. All sink basins shall have a center-rear outlet unless noted otherwise.

G. Electric water coolers (EWC) and drinking fountains shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Acorn Aqua, Elkay, Guardian, Halsey, Haws, Murdock, Oasis, Sunroc, Taylor or equivalent.

H. Hose bibs and wall hydrants shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Zurn, Jay R. Smith, Wade, Woodford, Acorn, Chicago, T&S Brass, Watts, Prier, or equivalent. Handles, if specified shall be constructed of metal or brass and finished to match valve unit.

2.2 FAUCETS

A. Plumbing fixture faucets shall be brass construction and fully chrome plated, unless special finish is specified on the Plumbing Fixture Schedule on the drawings. Faucets shall be furnished complete with all accessories required for the necessary application, including aerators, handles, spouts, and operating cartridges. Contractor shall coordinate exact faucet requirements with required fixture

drilling and water and waste rough-in. Faucets for handicapped fixtures shall meet all handicapped and ADA requirements, including a maximum of five (5) pounds of force to activate controls and adjustable metering faucet water flow duration of ten (10) seconds, minimum. Single hole faucets shall have anti-clocking pin to prevent rotation of valve body.

B. Plumbing fixture faucets shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as manufactured by Chicago, Delta, Moen, Speakman, T&S Brass, Zurn, or equivalent, and shall be commercial grade.

2.3 PLUMBING FIXTURE TRIM

A. Plumbing fixture trim including P-traps, supplies, and strainers shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as furnished by Chicago, Brass Craft, McGuire, T&S Brass, EBC, Zurn, or equivalent.

B. Unless otherwise specified, traps shall be copper-alloy adjustable tube-type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal-to-metal or metal-to-plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy, offset style, to match P-trap. Furnish brass or copper wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated.

C. Fixture supplies, strainers, and trim shall be brass construction. Supplies shall be commercial grade, quarter-turn all brass ball valves, plastic stems and handles are not acceptable. Furnish supply with loose key unless otherwise specified. Supply pipe shall be 3/8" O.D., with smooth (non-corrugated) flexible copper riser and wall escutcheon. Supply assembly shall be completely chrome plated for all exposed installations, including installation within cabinets and casework. Strainers and other miscellaneous fixture trim shall be furnished as required for the proper installation and shall be chrome plated to match faucets, unless special finish is required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide all necessary supports and connection materials and trim for plumbing fixtures as required to assure a complete properly installed and operating system. Installation shall be in accordance with manufacturer's recommendations and with International Building Code and Uniform Plumbing Code requirements. The Contractor shall caulk fixtures to the adjacent wall, floor and countertop construction with non-shrink, mildew resistance caulking material.

B. Fixture mounting height shall conform to the ADA Accessibility Requirements and coordinated with the Architectural drawings.

1. ADA required Water Closet shall be mounted with top of seat 17” – 19” above finished floor.

2. ADA required Urinal shall be mounted at a maximum of 17” top of rim to finished floor.
3. ADA required Lavatory to be mounted with the rim or counter surface no higher than 34” above finished floor.
4. ADA required shower controls shall be located from 38” minimum to 48” maximum height above the shower floor.
5. ADA required Bathtub controls shall be located maximum of 48” above bottom of tub surface.
6. ADA required Sinks shall be mounted with counter or rim no higher than 34” above finished floor.
7. ADA required Drinking Fountains or Water Coolers spouts shall be no higher than 36” measured from the floor or ground surface to the spout outlet.

3.2 EQUIPMENT/FIXTURE SUPPORT

A. Furnish and install all "back-up" materials for fixtures and accessories, or as otherwise required by the equipment schedule to properly support and provide a sturdy installation.

3.3 FIXTURE CARRIERS

A. Fixture carriers shall be provided for all wall hung plumbing fixtures, including water closets, urinals, lavatories, sinks, etc., as manufactured by Josam, Jay R. Smith, Watts, Wade, Zurn, MiFab, or equivalent. Carriers shall be bolted to the floor using all of the support bolts recommended by the manufacturer. Where the water closet nipple and studs extend beyond the maximum carrier recommended length, provide additional carrier support as recommended by manufacturer. Water closet carriers shall be horizontal or vertical, single or back-to-back units as required for the fixture installation and piping arrangement, and shall be adjustable.

B. Single water closet carriers shall have factory installed rear hold down lugs and anchor foot to provide cantilever support.

C. Wall hung urinals shall be provided with floor mounted fixture carrier complete with upper and lower fixture support plates as required to match fixture installation requirements.

D. Wall hung lavatories and sinks shall be provided with floor mounted concealed arm type chair carriers, single or double (back-to-back) units as required for the fixture installation and arrangement.

E. Contractor shall be responsible to provide the proper arrangement and selection of fixture carriers required for fully concealed installation in the available plumbing chase and/or wall construction.

3.4 FIELD MEASUREMENTS AND COORDINATION

A. Exact location and rough-in requirements shall be carefully coordinated. Contractor shall refer to drawings and specifications, and shall check manufacturer's data, shop drawings and rough-in drawing submitted under Division 22 and other Divisions of this specification and make all field measurements to the extent necessary to ensure his understanding of the work required to provide for complete rough-in installation.

3.5 CLEANING

A. All fixtures shall be thoroughly cleaned before final acceptance of the work.

END OF SECTION 224000

SECTION 226801 - OUTSIDE UTILITIES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions and Supplemental Conditions.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

C. Soldered joints below grade shall be made using Sil-Fos or Phos-Copper.

1.2 SCOPE

A. Domestic Water and Fire Protection Systems.

B. Sanitary Sewer Systems.

1.3 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 22 1100, Domestic Water Piping.

F. Section 22 1316, Sanitary Waste and Vent Piping.

G. Section 22 1123, Facility Natural Gas System.

1.4 GENERAL REQUIREMENTS

A. Excavation and backfilling shall conform to the requirements of Division 2 and Section 22 0503 on

Excavation, Trenching, and Backfilling for Utilities. Work covered by this section will not be accepted until backfilling connected with the work has been completed satisfactorily. Any section of the utilities that is found defective in material, alignment, grade, or joints before acceptance shall be corrected. All pipe and accessories shall be of new and unused material. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate the bells and joints. Any pipe that has the grade or joint disturbed after laying shall be taken up and relaid. The interior of the pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. The pipe shall not be laid in water, or when trench or weather conditions are unsuitable for the work. Water shall be kept out of the trench, until the joints are completed. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth or other substance will enter the pipes or fittings. Any section of pipe found to be defective before or after laying shall be replaced with new pipe without additional expense to the Owner. Minimum depth of trench for water piping shall provide 42 inches of cover over the pipe. Minimum depth of trench for gas shall be 30 inches for plastic or 24" for steel.

1.5 UNDERGROUND PIPING IDENTIFICATION

A. The location of each underground piping system shall be marked using a continuous, pre-printed, colored plastic ribbon tracer tape, as specified in Section 22 0500. Additionally, non-metallic underground piping shall be provided with a special detection type tape conforming to applicable Code requirements.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER AND FIRE PROTECTION SYSTEMS

A. General: Provide any of the following optional piping systems unless otherwise indicated on the plans. All pipe and accessories shall be new and unused. Piping, fittings, and specials shall be approved by the National Sanitation Foundation (NSF) for potable water service and shall be listed by UL and FM approved when required for fire protection service.

B. Ductile Iron Pipe, 36" Diameter and Smaller: Ductile iron pipe shall conform to AWWA Spec. C151, working pressure not less than 150 PSIG, unless otherwise shown or required. Pipe shall be cement-mortar lined in accordance with AWWA C104, with exterior bituminous coating. Pipe shall be encased with 20 mil. thick polyethylene in accordance with AWWA 105. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

1. Joints: Mechanical joints shall be of the stuffing box type and shall conform to AWWA C110. Push-on joints shall conform to AWWA C110 and C111. Rubber gaskets and lubricant shall conform to the applicable requirements of AWWA C111.
2. Fittings and Specials: Fittings and specials for ductile iron pipe shall be suitable for 150 PSIG rating, unless otherwise shown or required. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and C111. Fittings and specials shall be cement lined in accordance with AWWA C104, with exterior bituminous coating. Compact fittings shall be in accordance with AWWA C153. Flanged joints (in concrete pits, tunnels, and equipment

rooms) shall conform to AWWA C115.

C. Polyvinyl chloride (PVC) Plastic Pipe: All pipe, couplings, and fittings shall be manufactured of material conforming to ASTM D1784, Class 12454B.

1. Pipe less than 4" diameter:

a. Screw-Joint: Pipe to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 150 PSI working pressure, 200 PSI hydrostatic test pressure, unless otherwise shown or required. Pipe couplings when used, must be tested as required by ASTM D 2464.

b. Elastomeric-Gasket Joint: Pipe shall be to dimensional requirements of ASTM D 1785, Schedule 40 with joints meeting the requirements of 150 PSI working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D 2241, elastomeric joint, with the following applications:

SDR	Maximum Working Pressure	Minimum Hydrostatic Pressure
17	150	200
13.5	200	266

c. In addition to the above requirements, the pipe, couplings and fittings must be hydrostatically tested as required by AWWA C900, and must be to iron pipe (I.P.S.) or cast iron outside diameter (CIOD) size dimensions.

d. Solvent Cement Joint: Pipe to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 150 PSI working pressure and 200 PSI hydrostatic test pressure.

D. Joints: Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendation as approved by the manufacturer.

E. Fittings:

1. For PVC pipe less than 4-inch diameter: Fittings for threaded pipe shall conform to the requirements of ASTM D 2464, threaded to conform to the requirements of ANSI B1.20.1 for use with Schedule 80 pipe and fittings. Fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467. Fittings for elastomeric-gasket joint pipe shall be ductile iron conforming to AWWA C110 or AWWA C111, as specified above for ductile iron pipe.
2. Fittings for PVC pipe 4-inch diameter and larger: Fittings and specials shall be cast iron or ductile iron pipe, bell end in accordance with AWWA C110 or mechanical joints in accordance with AWW C111, 150 PSI pressure rating minimum, except that profile of bell may have special dimensions as required by the pipe manufacturer; or may be fittings and specials of the same material as the pipe with elastomeric gaskets, all in conformance with the requirements of AWWA C900. Cast-iron and ductile iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104, with exterior bituminous coating. Fittings shall be for bell and spigot pipe or plain end pipe, or as

applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

F. Copper Pipe 3-inch and smaller: Type K or Type L annealed, soft drawn tubing or hard drawn pipe in accordance with ASTM B88.

1. Joints: Joints shall be compression pattern flared or solder type using lead-free solder and flux. Surfaces to be soldered shall be cleaned bright by manual or mechanical means. All joints shall be properly fluxed with a non-corrosive lead-free flux manufactured to approved standards, Federal Specification QQ-S-517. Solder joints for underground piping shall be composition silver solder for all sizes.
2. Fittings: Fittings and specials shall be flared conforming to ANSI B16.26 or wrought copper or cast brass pressure fittings conforming to ANSI B16.22 and B16.23.

G. Gate Valves: Gate valves shall be designed for a working pressure of not less than 150 PSI. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening. Valves shall be furnished in non-rising stem arrangement with two-inch square wrench nut for underground installation. Non-rising stem valves shall be furnished with AWWA stuffing box or with indicator post flange with O-ring seals where indicator post is required. Valves for above ground installation and installation within pits; vaults and tunnels shall be furnished with outside screw and yoke (OS&Y) with non-asbestos packing and hand wheel. Underground valves shall be furnished with either mechanical joint or hub connections as required for the application. OS&Y gate valves shall be furnished with flange connection, Class 125, conforming to ANSI B16.1. Working pressure shall be a minimum of 175 PSIG for valves 4-inch through 12-inch sizes, and 150 PSIG for 14-inch and larger size. All valves for fire protection service shall be UL and FM approved. Underground valves shall be provided with an approved field applied coating as specified for underground steel pipe and fittings.

1. Valves 3-inch and smaller shall be all bronze designed for screwed fittings, and shall conform to MSS SP-80, Class 150, Type 1. See Section 22 0700.
2. Valves 4-inch and larger shall be iron body bronze mounted, and shall conform to AWWA C500, with double wedge disc, 4-inch through 14-inch, Mueller A-2050 Series NRS hub ends or mechanical joint ends, and Mueller A-2073 Series OS&Y flange ends, or equivalent. Resilient seat gate valves, 4-inch through 12-inch, shall conform to AWWA C509, Mueller A-2075 Series NRS, hub-ends or mechanical joint ends and Mueller A-2078 Series OS&Y flange ends, or equivalent.

H. Indicator Post: Indicator post for fire protection line shall conform to the requirements of NFPA No. 24, shall be adjustable cast iron type, and shall be listed by Underwriters' Laboratories and Factory Mutual approved. Furnish extension section and stem as necessary for required depth of bury and finish grade. Furnish complete with tamper switch as specified in accordance with the requirements in Division 21, Fire Suppression. Electrical connections shall be furnished and installed in accordance with Section 22 0549 and Division 26, Electrical. Indicator Post shall be Mueller Co., Model A-20804, or equivalent.

I. Valve Boxes: Valve boxes shall be cast iron or concrete, except that concrete boxes shall not be installed in locations subject to vehicular traffic.

1. Cast iron valve boxes shall be of the extension type with flared base and shall be two piece,

5-1/4" shaft, screw type, with water cover. The cover shall have the word "WATER" cast in the metal. Boxes shall be installed over each outside gate valve unless otherwise shown on the drawings. The boxes shall be of such length as will provide a cover of not less than 3 ft. over the pipe. Tyler Pipe, 665 Series, or equivalent. The valve box shall be protected against movement by a concrete pad 12 inches square, minimum, and 4" thick.

2. Concrete boxes shall be the standard product of a manufacturer of precast concrete products. The word "WATER" shall be cast in the cover. The boxes shall be of such length as will be required for the depth of cover required over the pipe at the valve location.

J. Tapping Sleeves and Valves: Wet taps under pressure for connections to existing water mains shall be made using tapping sleeve constructed of cast iron, ductile, or malleable iron, split sleeve type with bolts, follower rings and gaskets on each end of the sleeve, and ANSI B16.1 Class 125 flange connection for tapping valve. Tapping valve outlet connection shall be mechanical joints or hub-end with flange for attachment of required tapping/drilling machine. Valve and sleeve construction shall be for a minimum of 150 PSIG, for 4-inch through 12-inch nominal size, shall conform to AWWA requirements, and shall be UL/FM approved for fire protection service. Mueller H-629 tapping sleeve and H-698 (hub-end) or H-699 (mechanical joint end), or equivalent.

K. Backflow Protection: All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.

1. Reduced pressure backflow preventer assembly shall be installed by the Contractor. Backflow preventer size and arrangement shall be as indicated on the drawings. All costs, fees, and permits required shall be secured and paid for by the Contractor, unless otherwise indicated.
2. See Section 22 1100 for backflow protection.

L. Backflow Preventer Enclosure: Furnish and install factory fabricated backflow preventer enclosure consisting of insulated sheet metal housing with access panel/doors and drain provision. Housing shall be fabricated from galvanized, paint grip sheet metal panels, and faced insulation. Housing shall be supported with heavy gauge galvanized steel angle braces and support members. Panels shall be assembled such that any panel can be removed for access. Furnish hinged access door for required personnel and equipment access into enclosure. Housing insulation shall be minimum 1-1/2" thick closed cell faced insulation with a minimum R-value of 5.8°F, ST/HR/BTU per inch. The housing shall include an integral insulated hinged panel designed to open against hydrostatic pressure. The opening area of the hinged panel shall be sized to comply with applicable code requirements and to relieve the required discharge from the backflow preventers. The arrangement, size, and location of the enclosure shall be in accordance with details shown on the drawings. Furnish concrete pad for enclosure base and all required supports and anchors necessary for piping and materials within the enclosure. Concrete shall have compressive strength of 3000 PSI minimum, and shall be furnished and installed in accordance with the applicable requirements contained within Division 3 of this specification. Enclosure housing shall be furnished with primer coating for finished painting under the painting sections of this specification. Fully compliant with ASSE 1016. Backflow enclosure shall be by HydroCowl, Hot Box, or equivalent.

1. Furnish and install electrical resistance heater as specified in the drawings and as required to maintain the temperature within the enclosure of a minimum of 40°F, based on an outdoor ambient temperature of 0°F and a wind speed of 15 MPH. Electric heater shall include integral thermostat and all required safety and operating controls and shall be suitable for use with 120 volt, single phase, 60 hertz voltage.
2. Furnish and install electric heat tracing system for all piping and equipment above grade within the enclosure. Heat tracing system shall be self-regulating heating cable and shall be provided in accordance with the requirements contained in Section 22 0505.
3. Backflow preventer enclosure, arranged, size, and location, shall be provided in accordance with the details shown on the drawings, and shall provide access to backflow preventers as recommended by manufacturer for all necessary service, maintenance, and testing.

2.2 SANITARY SEWER SYSTEM

A. General: Provide any of the following optional piping systems unless shown otherwise on the plans. All pipe and accessories shall be new and unused.

B. Cast iron Soil Pipe, 2" through 15" service: Cast iron pipe shall conform to ASTM A-74, service weight, bell and spigot, bituminous coating.

1. Fittings: Cast iron sanitary drainage fittings, service weight, bell and plain end to match piping system, bituminous coating.
2. Joints: Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum or double seal compression type molded neoprene rubber gaskets suitable for the class of pipe being jointed.

C. Polyvinyl chloride (PVC) Sewer Pipe 4" and larger: PVC sewer pipe shall be ASTM D3034, Type PSM, with a maximum SDR of 35 for piping 15" diameter and smaller; ASTM F949 for corrugated sewer pipe with a smooth interior for piping size 4" through 10" diameter; and ASTM F679 for large diameter gravity sewer piping 18" diameter and larger.

1. Fittings: Fittings for PVC drainage type piping shall be solvent cement or bell and spigot joint in accordance with ASTM D3212, and Uni-Bell UNI-B-4 and B-7, as applicable.
2. Joints: Joints for PVC piping system shall be either solvent cement type conforming to ASTM D2844, or elastomeric seal type conforming to ASTM D3212.

D. Cement Mortar: Cement mortar shall conform to ASTM C270, Type M, with Type II cement.

E. Portland Cement Concrete: Portland cement shall conform to ASTM C150, sulfate resistant Type II or V, as recommended for the installation, application, and location. Concrete shall conform to ASTM C94, compressive strength shall be a minimum 4000 PSI at 28 days, except for concrete thrust blocking, for cradle and encasement, or for concrete blocks for manholes, which shall have a compressive strength of 2500 PSI minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days. Concrete shall be furnished and installed in accordance with the applicable requirements contained within Division 3 of this specification.

2.3 NATURAL GAS SYSTEM

A. The gas distribution system is intended for the distribution of natural gas and the materials,

appurtenances and workmanship used in this system shall be suitable and approved for natural gas service. Any section of the gas distribution system that is found defective in materials or workmanship before acceptance shall be corrected.

B. Plastic pipe welders shall be qualified in heat fusion techniques in accordance with Federal Standard 49 CFR, Part 192.285, and shall have in their possession evidence of such qualifications. Welders for steel piping shall be certified in accordance with the provision contained within Section 22 0500.

C. Contractor shall have a written procedure approved by the State of New Mexico for installation of polyethylene gas piping. Submit evidence of qualifications prior to commencing work on the natural gas piping system.

D. The gas system shall conform to the applicable requirements of all State of New Mexico codes and ordinances including the Uniform Plumbing Code, and Uniform Mechanical Code, NFPA No. 54, and to the rules and regulations of the Utility Company supplying the gas, including the U.S. Department of Transportation "Pipeline Safety Regulations, Part 192, CFR-49.

E. In shipping, delivering, and installing, pipe and accessories shall be handled in such manner as to ensure a sound, undamaged condition. Particular care shall be taken not to injure pipe and pipe coatings. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied. Coated and wrapped steel pipe shall be handled in conformance with the American Water Works Association Specification C204.

F. Submit manufacturer's catalog data and installation procedures on pipe, fittings, valves, risers and other material to be incorporated into construction for the natural gas distribution system.

G. Piping: Provide any of the following optional piping systems unless shown otherwise on the plans. All pipe and accessories shall be new and unused.

1. Polyethylene Plastic Pipe: Underground natural gas piping distribution system shall be black or yellow polyethylene plastic natural gas distribution pipe with heat fusion joints. Pipe shall be PE-2406, PE-3406, or PE-3408 in accordance with ASTM D2513, as manufactured by POLY-ARK, PLEXCO, Poly-Pipe or equivalent. Contractor shall use the same type and designation of piping throughout the project. Piping shall have approved tracing system (copper 14 gauge wire, or tape) and shall be installed in compliance with all requirements of Authority in jurisdiction.

    a. Risers: Anodeless risers shall consist of polyethylene encased steel pipe sweeps integrally connected to appropriately sized polyethylene pipe at the bury end with threaded IPS connections at the exposed end. Risers shall be as manufactured by Wayne or equivalent. Above ground piping and fittings used to connect to building services shall be black steel, Schedule 40, as specified in Division 23, Section 23 07 00. Incidental below-ground pipe and fittings shall conform to the above specifications and shall be coated and wrapped.
    b. Valves and Valve Boxes: Natural gas main valves shall be plastic valves of the size specified suitable for gas service, compatible with the polyethylene pipe utilized, and conforming to ANSI, Bl6.40, with a minimum working pressure of 125 PSIG, Rockwell or equivalent. Valves shall be installed in cast iron valve box and cover as specified under section for Water Systems, and shall be marked with "GAS" on cover.

2. Steel Pipe: Steel pipe used for the installation, extension, alteration, and/or repair of any gas piping system shall be black steel pipe ASTM 120 or A53 Grade A or B, ERW or BW, standard wall, Schedule 40. All underground steel pipe shall be coated and wrapped in accordance with AWWA C204 and Section 22 0504.
   a. Fittings: Fittings for steel piping 2" and smaller shall be either screwed or welded, except all underground piping system fittings and joints shall be welded. Screwed fittings shall be Class 150 standard black malleable iron conforming to ANSI B16.3. Weld fittings shall be either standard weight steel butt-weld fittings conforming to ANSI B16.9, or forged steel socket-weld fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.
   b. Flanges: Flanges for steel piping system shall be forged steel, weld neck, or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished. Gaskets shall be 1/16" thick full face non-asbestos material suitable for the temperatures and pressure application. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.
   c. Valves and Valve Boxes: Valves shall be as specified in Section 23 0523, Valves and shall be approved for the required service. Valves shall be installed in cast iron valve box and cover, as specified under Section for Water Systems, and shall be marked with "GAS" on cover.

H. Gas Meters:

1. Natural gas meters shall be furnished and installed by the natural gas utility company, unless otherwise indicated on the drawings. All required permits and fees shall be secured and paid for by the Contractor in accordance with Section 22 0500, Common Work Requirements for Plumbing. Gas meter shall be the type of capacity required for the application and shall be located as indicated on the drawings and in accordance with [utility company requirements and applicable codes and ordinances. All natural gas meters shall be preceded by a main gas supply shut-off valve serviceable and accessible outside the building.
2. See Division 22, Section 22 1123, Facility Natural Gas System for natural gas meters.
3. Natural gas meters shall be furnished and installed by the Contractor in accordance with the information shown on the drawings and in the plumbing equipment and fixture schedule on the drawings.
4. See Division 23, Section 23 0900, Facility Management Systems, for meters and instrumentation.

I. Natural Gas Regulator:

1. Natural gas regulator shall be furnished and installed with the gas meter by the utility company, and set for the required gas leaving pressure shown on the drawings.
2. See Division 22, Section 22 1123, Facility Natural Gas System for natural gas meter and regulator.
3. Natural gas regulators, as specified on the plumbing equipment and fixture schedule and as shown on the drawings, shall be furnished and installed by the Contractor.

PART 3 - EXECUTION

3.1 GENERAL

A. Install utility service lines to a point of connection to the building service lines, approximately five (5) feet outside of the building, and make connections to the building service lines in an approved manner. See the applicable specification sections for requirements associated with the building service lines. All non-metallic piping systems installed under this section of the specification shall terminate approximately five (5) feet from the building and piping system materials approved for installation within the building and specified in the applicable sections shall be provided for connection to the underground utility systems and extension to the building.

B. Installation of utility piping distribution systems including domestic cold water, fire protection, sanitary sewer, and natural gas systems shall be installed as specified herein and in strict accordance with manufacturer's recommendations.

C. In shipping, delivery, and installation pipe and accessories shall be handled in such manner as to ensure sound undamaged condition.

D. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized. Cutting shall be done by means of an approved type of mechanical cutter. Wheel cutters shall be used whenever possible.

E. Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. Standard methods are available for making connections to various types of pipe, either under pressure or in the dewatered condition.

F. Pipe passing through walls of vaults, pits, and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be sealed in accordance with requirements contained in Section 22 0504.

G. Flanged pipe shall only be installed above ground or within vaults, pits, or structures only.

3.2 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including Uniform Plumbing Code and Uniform Mechanical Code, and NFPA No. 54, National Fuel Gas Code.

C. Where the location of the water and sewer lines are not clearly defined in dimensions on the drawings, the water line shall not be laid closer horizontally than ten (10) feet from a sewer except where the bottom of the water line will be at least 12 inches above the top of the sewer line, in which case the water line shall not be laid closer horizontally than six (6) feet from the sewer. Where water

lines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least ten (10) feet each side of the crossing shall be fully encased in concrete or shall be made of pipe material approved for use within the building, with no joint located within three (3) feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains and shall be not less than two (2) feet above the sewer main. Joints in the sewer main, closer horizontally than three (3) feet to the crossing, shall be encased in concrete.

D. Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric systems.

E. Copper tubing shall not be installed in the same trench with ferrous piping materials. Where copper tubing crosses any ferrous piping material, a minimum vertical separation of 12 inches must be maintained between pipes.

F. Where utility piping systems are required to be installed within three (3) feet of existing or new structures, the pipe shall be of a material approved for installation within the building or shall be installed within a sleeve of rigid conduit to a point 10'-0" on either side of the structure. Care shall be exercised and proper precautions taken during installation of the pipe and sleeve to assure that there will be no damage to the structure and no settlement or movement of foundations or footings. Any damage occurring as a result of the Contractor's operation shall be corrected and all costs connected therewith shall be borne by the Contractor.

3.3 JOINT DEFLECTION

A. Cast Iron and Ductile Iron Pipe: The maximum allowable deflection will be as given in AWWA C600 and as recommended by the manufacturer. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

B. Plastic Pipe: Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer, but in no case shall it exceed five (5) degrees.

3.4 DOMESTIC WATER AND FIRE PROTECTION SYSTEMS

A. Placing and Laying: While suspended in the sling and before lowering into the trench, the pipe shall be inspected for defects and tapped with a light hammer to detect cracks. Defective, damaged, or unsound pipe will be rejected. As the work progresses, the interior of the piping shall be cleared of all dirt and debris. Trenches shall be kept free from water until the pipe jointing has been completed. Pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. At all times when the work is not in progress, all open ends of pipe and fittings shall be maintained securely closed. Unless in conflict with other provisions of these specifications, Section 7 of AWWA C600-54T shall apply in placing and laying of ductile iron pipe. Minimum depth of cover over buried water lines shall be three (3) feet.

B. Jointing:

1. Copper Tubing: Joints shall be made with solder or flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so

there is metal-to-metal contact. Solder joints shall be composition silver solder as specified in Sections 22 0504 and 22 1100.

2. Ductile-Iron Pipe: Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines.

C. Polyvinyl Chloride (PVC) Plastic Pipe:

1. (PVC) Plastic Pipe Less Than 4-Inch Diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with requirements of ASTM F 477 and as required herein. All pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. Care shall be exercised to assure the gasket and ring groove in the bell or coupling match. The manufacturer of the pipe or fitting shall also supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall utilize sockets conforming to the requirements of ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.
2. (PVC) Plastic Pipe 4-Inch through 12-Inch Diameter: Joints shall be elastomeric-gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 4-inch diameter with configuration utilizing elastomeric ring gasket.
3. (PVC) Plastic Pipe 14-Inch through 36-Inch Diameter: Joints shall be elastomeric-gasket push-on joints made in accordance with AWWA M23.

D. Torque Wrench Test on Bolts for Mechanical Joints: The Contractor shall provide a torque wrench of a length which will allow testing of bolt tightening by the authorized representative. Before backfilling and pressure testing, the bolts of each joint shall be tested to a torque as recommended by the joint manufacturer.

3.5 THRUST RESTRAINT

A. Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, on waterlines, and fire hydrants shall be provided with thrust blocking, and/or metal tie rods and clamps or lugs, as required. Valves shall be securely anchored or shall be provided with thrust blocking to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints as specified herein.

B. Thrust Blocks: Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2,000 PSI after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. The base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps shall be protected by galvanizing or by coating with bituminous paint.

C. Restrained Joints: For ductile-iron pipe, restrained joints shall be designed by the Contractor or the joint manufacturer in accordance with DIPRA-01 and manufacturer's joint instructions and recommendations. Joint restraint shall be constructed of ductile iron with follower gland, including restraining mechanism which imparts multiple wedging action against the pipe when properly installed. Restraint joint shall have a minimum 250 PSIG working pressure and shall be manufactured by EBAA Iron, Inc., MEGALUG, or equivalent.

3.6 TESTING OF WATER SYSTEMS AND FIRE PROTECTION

A. General: Where any section of a water line is provided with concrete thrust blocking for fitting or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking.

B. Pressure Test: After the pipe is laid, the joints completed, valves permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 1.5 times the system maximum system operating pressure but neither less than 125 PSIG nor greater than 200 PSIG. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, and valves, discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory.

3.7 DISINFECTION

A. Each section of completed water system shall be disinfected as specified herein. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite. The chlorinating material shall provide a dosage of not less than 50 PPM and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the chlorinating material in solution. In no case will the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. The retention time shall be at least 24 hours and shall produce not less than 25 PPM of free chlorine residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 PPM. During the flushing period, each fire hydrant on the line shall be opened and closed several times. Water lines or distribution systems will not be accepted until a potability test by an approved water testing laboratory is made on water taken from the system and dosing will be repeated as necessary until such negative test is accomplished. Contractor shall furnish copies of final lab test reports for the water system.

3.8 SANITARY SEWER SYSTEMS

A. Pipe Laying:

1. Pipe shall be protected during handling against impact shocks and free fall and the pipe interior shall be free of extraneous material.
2. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the required line and grade. Pipe shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.
3. Before making pipe joints all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted so as to provide a water tight system.
4. For solvent cement systems, all joints shall be thoroughly coated with solvent weld material to ensure that there will be no water or air passage at the joint between the inner or outer wall of the pipe. Installations of solvent weld joint pipe and fittings shall be installed in accordance with ASTM F 402, and all required precautions shall be taken to assure adequate trench ventilation and protection for workers installing the pipe.

B. Caulked Joints: The packing material shall be well packed into the annular space so as to prevent the entrance of lead into the pipe. The remainder of the space shall be filled with molten lead that is hot enough to show a rapid change in color when stirred. Scum shall be removed before pouring. The lead shall be caulked to form a tight joint without overstraining the bell and shall have a minimum depth of 1 inch after caulking. Gasket joints shall be double seal compression type molded neoprene rubber, suitable for the class of piping being jointed.

C. Trenches and Backfill: Trenches shall be kept free of water and as dry during bedding, laying, and jointing. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no water or other material will enter the pipe or fittings. After the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light.

D. Wye Branches: Wye branches shall be installed for sewer connections where indicated on the drawings. When conditions are such that the connecting pipe cannot be adequately supported on undisturbed earth or completed backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method shall consist of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.9 CLEANOUTS

A. The size of cleanouts shall be of the same size as the line to which it is connected, except that cleanouts need not be larger than 4". Pipe and fittings for cleanouts shall be cast iron with hub and spigot joints unless otherwise shown on the drawings. Cleanouts shall be constructed in accordance with details shown on the drawings. Iron ferrules shall be provided as shown on the drawings. Cleanout plugs shall be brass.

3.10 INSPECTION OF SEWERS

A. Sewers shall be inspected and approved before being backfilled. Thoroughly flush out before inspection. Lamp between manholes, or other points as directed, and show full bore indicating sewer is true to line and grade. Lips at joints on inside of sewer will not be permitted.

3.11 TESTING OF SANITARY SEWERS

A. Upon completion of the sewer construction, tests will be required on all sanitary sewer lines.

B. Air Test: Make air test when sewer is clean. Plug line at each manhole with pneumatic balls. Introduce low pressure air into plugged line until internal air pressure reaches 4.0 PSIG greater than average back pressure of any ground water pressure that may submerge the pipe. Allow at least two minutes for air temperature to stabilize before readings are taken and timing started. Portion being tested shall pass if it does not lose air at a rate to cause pressure to drop from 3.6 to 3.0 PSIG greater than average back pressure of any ground water that may submerge the pipe in less time than listed below:

Pipe Diameter In Inches	Minimum Allowable Minutes (3.6 - 3.0 PSIG Pressure
4	2.0
6	3.0
8	4.0
10	5.0
12	6.0
15	7.5

C. Exfiltration Test: In lieu of standard sanitary sewer air test, Contractor may make exfiltration tests on sewers. Subject pipe to hydrostatic pressure produced by head of water at depth of three feet above invert of sewer at upper manhole under test. In areas where ground water exists, head of water shall be three feet above existing water table. Maintain head of water for a period of one hour during which it is presumed that full absorption of pipe body has taken place, and thereafter for a further period of one hour for actual test of leakage. During one hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 3.0 gallons per hour per 100 feet. In event that measurements indicate exfiltration greater than maximum allowable leakage, additional measurements shall be taken and continued until leaks are located and necessary repairs and corrective work have reduced leakage in section being tested below maximum allowed by specifications. For purpose of test, line between adjoining manholes will be considered a section and will be tested as such.

D. Infiltration Test: If ground water level is greater than three feet above invert of the upper manhole, infiltration tests may be allowed in lieu of the above tests. Allowable leakage for this test will be the same as for the exfiltration test.

E. Pumped Systems: Piping for pumped drainage systems shall be pressure tested as specified in this section for water systems at a minimum pressure equal to the system working pressure.

3.12 COMMISSIONING SYSTEM

A. The Contractor shall furnish, install, and set all regulators based on capacity and pressure as shown on drawings. Provide a plugged tee for measuring downstream pressure from regulator. A U-tube water manometer shall be used to adjust the leaving pressure. Provide a record of the entering and leaving pressure for each regulator.

3.13 CLEANUP

A. Upon completion of the installation of all outside utilities, Contractor shall remove all surplus construction materials and debris resulting from the work.

END OF SECTION 22 6801

SECTION 230500 - COMMON WORK REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this Section and all subsequent sections of this Division and form a part of the contract.

C. See Division 2, Site Work for additional requirements regarding Trenching, Backfilling for buried piping.

1.2 INDEX OF SPEC SECTIONS FOR THIS DIVISION

23 0500	Common Work Requirements for HVAC
23 0504	Pipe and Pipe Fittings
23 0505	Piping Specialties
23 0523	Valves
23 0549	HVAC and Electrical Installation Coordination
23 0593	Testing, Adjusting and Balancing of Mechanical Systems
23 0700	Mechanical Systems Insulation
23 0810	Performance Assurance Contractor HVAC Systems
23 0900	Automatic Controls for HVAC Systems
23 3000	Air Tempering System and Equipment
23 7413	Packaged Outdoor Central Station Air Handling Units

1.3 DESIGN INTENT

MECHANICAL HVAC SYSTEM

New HVAC system will consist of a high SEER / high efficiency packaged rooftop air handling unit (RTU) with variable speed compressors and electronically commutated motor (ECM) fan motors, a full outside air dry bulb economizer “free cooling”, a direct expansion (DX) cooling coil, and a natural gas fired furnace heating section. Each RTU will provide heating, cooling, and provide minimum outside air ventilation during occupied times as required by ASHRAE 62.1 2007 for the number of occupants in each space. When outdoor ambient conditions are favorable, the use of outside air for cooling via the economizer will be utilized for energy reduction. Each RTU will be provided with a programmable thermostat.

Gymnasium

Existing HVAC system consists of two (2) packaged rooftop unit with DX cooling and gas heating. All HVAC systems are operational and in working condition. The supply and return air distribution system is ductwork located above the corridor ceiling to each zone sidewall air distribution. No new work is

anticipated in the gymnasium.

MDF, IDF & Electrical Rooms

MDF, IDF, and Electrical rooms (with transformer only) will be served by a dedicated HVAC split DX system.

Exhaust Requirements

All restrooms are exhausted at a rate of two cubic feet per minute per ft2 or 16 air changes per hour per ASHRAE. A dedicated exhaust and/or purge exhaust system will be provided for each art classroom, special education, and nurse/cot area.

References:

The mechanical and electrical system design will adhere to the following codes to ensure safe and proper installation of the system.

Uniform Mechanical Code (UMC – 2012)

Uniform Plumbing Code (UPC - 2012)

International Building Code (IBC -2015)

National Fire Protection Association (NFPA - Latest Edition)

American Society of Heating, Refrigeration, Air Conditioning Engineers (ASHRAE)

Americans with Disabilities Act (ADA)

National Fire Protection Code & Life Safety NFPA

New Mexico Public School Facilities Authority (PSFA) Design Guidelines

State of New Mexico Electrical Code

Design Conditions:

Climatic:

- Location: Portales, New Mexico
- Elevation: 4,000 feet above sea level
- Winter 99.6% Design Dry-bulb: 11.7 F
- Summer 0.4% Design Dry-bulb/Wet-bulb: 97° F/63.4 ° F

Indoor Design Conditions:

Space	Winter (^{O}F)	Summer (^{O}F)	Relative Humidity (RH%)
General	72	75	N/A
Classrooms	72	75	N/A
Library	72	75	N/A
Office	72	75	N/A

Envelope Construction:

See Architectural.

Interior Loads:

People: 250 British thermal units per hour (Btu/hr) (sensible), 200 Btu/hr (latent). Space occupancy will be based on architectural furniture plans and ASHRAE standards where no information is available.

Ventilating and Indoor Air Quality Strategies:

Use ASHRAE Standard 62.1-2007 to meet ventilation and indoor air quality requirements.

Packaged Roof Top Unit will include a motorized minimum outside air damper and modulating outside air damper that will allow up to 100% outdoor air as part an economizer cycle. Full outside air will be used cooling when outdoor ambient conditions permit.

Provide filters capable of MERV 8 efficiency. Provide 2 extra/spare sets of Merv 8 Filters per unit.

Noise Requirements:

Standard design per ASHRAE for normally occupied areas.

1.4 DEFINITIONS

A. General: Terms will have meanings as defined in Webster's Eleventh New Collegiate Dictionary except as noted below.

B. Entities

1. Owner: Portales Public Schools
2. Architect: Formative Architecture
3. Engineer: Bridgers & Paxton
4. Owner's Representative: The Owner will designate his representative after bid. The abbreviation "OR" may be used throughout these specifications to refer to the Owner's Representative.
5. Owner's Agents: The Architect, Engineer, and others authorized to act on behalf of the Owner.

C. Actions

1. Supply: Procure and deliver to the site with all features as specified, required per code, and as required for proper installation. Include submittals, O&M manuals, operator instructions, and warranty.
2. Install: Set in place in accordance with manufacturer's instructions, contract documents, and applicable codes and standards. Coordinate the installation with other disciplines,

start, and demonstrate proper operation.
3. Furnish: Supply and install.
4. Provide: Supply and install.
5. Accepted: By the Owner's Representative except as noted.
6. Approved: By the Owner's Representative except as noted.
7. Review: By the Engineer except as noted.

D. Locations

1. Buried: Surrounded by soil or other material, either beneath the building or exterior to the building.
2. Exterior: Exposed to rain or snow. Examples include rooftop locations, spaces around cooling towers, pipe racks, etc.
3. Interior: Not exterior or buried. Examples include not only spaces within the heated envelope of the building, but also unheated attics, covered loading docks in which spaces are protected from rain and snow, utility tunnels, sheds, etc.
4. Finished Spaces: Interior spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated attics, spaces above ceilings, crawlspaces, and tunnels.
5. Exposed: Exposed to view. Examples include finished spaces mechanical equipment rooms, rooftops, etc.
6. Concealed: Not Exposed.

E. Other Definitions:

1. 24/7: 24 Hr/day, 7 days per week, year-round.
2. AHJ: Authorities having jurisdiction. The authorities having jurisdiction over this project are established by statute, and include governmentally designated building departments, the fire marshal, fire departments, etc. No attempt is made to list all such entities here; a qualified Contractor is expected to know and coordinate with the various authorities having jurisdiction.
3. FMS: Facility Management System
4. Local: Based no further from the job site than the Engineer is. For example, where the specifications call for a local factory authorized service agent, then on a daily basis that agent must be based in an office or warehouse located no further from the project site than the Engineer's office.
5. OAE: Or approved equal.

1.5 CODES AND PERMITS

A. Perform all work in accordance with the 2015 International Building Code, the 2012 Uniform Plumbing Code, and the 2012 Uniform Mechanical Code, as adopted and interpreted by the State of New Mexico and the City of Los Alamos, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. Contractor shall hold and save the Owner and his agents free and harmless from liability of any nature or kind arising from the Contractor's failure to comply with codes and ordinances.

B. Secure and pay for all permits necessary for performance of the work, including utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas, unless otherwise specified herein.

C. Comply with the requirements of, and the recommendations of:

1. Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances
2. National Electrical Manufacturer's Association
3. National Electrical Code
4. Underwriters Laboratories
5. American National Standards Institute
6. American Society for Testing Materials
7. Local utility companies
8. National Fire Protection Association
9. ASME Boiler and Pressure Vessel Codes
10. Occupational Safety and Health Administration
11. International Fire Code
12. Midwest Insulation Contractors' Association (MICA)
13. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
14. American Society of Sanitary Engineering
15. American Gas Association

1.6 PRIOR APPROVAL

A. Refer to Division 1 for Prior Approval Requirements.

B. Equipment manufacturers and service providers are listed within the specifications for the work specified in this division. For the items listed below, the specified manufacturers and providers are the only ones presently approved, and may be the only ones allowed:

Facility Management System

C. Manufacturers and service providers who are not listed in these specs, and who offer equivalent or superior products or services, are invited to submit for approval prior to bid (prior approval). Submit two copies. Requests for prior approval must:

1. Include the substitution request form at the end of this spec section.
2. Include technical data sufficient for the Engineer to generally assess appropriateness for this project.
3. Be submitted minimum ten days prior to the bid date in effect at the time of submission.
4. Comply with any additional requirements per specification Division 1.

D. Any additional prior approved alternate manufacturers and service providers will be published in an addendum prior to bid. Prior approval indicates that based on the information submitted it appears to the Engineer that the alternate might be capable of meeting the specifications and the design intent, and might be appropriate for the project. But prior approval does not guarantee this. Prior approved products and service providers must still go through the submittal process after award, and must still comply with the design intent and all specification requirements.

E. Please do not request prior approval for products and service providers that are not listed above. Instead, for those items alternate manufacturers and alternate service providers may be submitted after bid in accordance with the submittal process, provided they meet or exceed the specifications and the indicated design intent.

F. Prior approval (approval prior to bid) of alternate mechanical equipment suppliers and service providers is not required. Please do not request prior approval. Alternate manufacturers and service providers may be submitted after bid in accordance with the submittal process provided they meet or exceed the specifications and the indicated design intent.

1.7 DOCUMENT MANAGEMENT

A. Contractor is required to the e-Builder document management system for RFIs and submittals. If used, Contractor shall provide and pay for licenses and training for the engineer's project personnel. The section below describes procedures for handling submittals if a web-based document management system is not used. If a web-based system is used, the procedures below shall be modified as appropriate.

1.8 SUBMITTALS

A. See Division 1 and individual specification sections within this division for additional submittal requirements.

B. Prior to purchasing materials, equipment and services, submit descriptive literature for review.

C. See Division 1 and individual specification sections within this division for additional submission requirements. The following describes general submittal procedures. More specific procedures will be established after award. Whenever electronic files are to be submitted, e-mail them through normal channels. But if files are too large to e-mail, then submit them in quantities as described below.

1. Submittal Schedule: See Division 1 for format and submittal procedure.
2. Engineer will review one original submittal and one resubmittal for each item. If the Contractor fails to provide the required data or acceptable items with his second submittal, he will be charged for the Engineer's costs for the third and subsequent reviews.
3. Required Information: Submit information to allow the Engineer to easily determine whether the submitted components comply with the general design intent. Include relevant descriptions of materials, features, performance, quality and dimensions. Cross out all features, options and accessories which will not be provided. It is assumed that all specified, indicated and/or required features will be provided unless specifically noted otherwise.
4. Where specifications require a local factory authorized service agent, submit the name, address, and contact information for this agent. Include this information also in the O&M Manual.

D. Review of Submittals: Engineer will review submittals for general conformance with the design intent.

1. Review of a separate item as such will not indicate review of the assembly in which the item functions.
2. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work.
3. Review will not relieve the Contractor of responsibility to comply with the contract requirements, or responsibility to ensure that equipment fits within the allotted space with required clearances for equipment operation, service and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC).
4. For commodity type items (plumbing fixtures, terminal units, registers, diffusers, etc), Engineer will review submittals for type only. Contractor to coordinate sizes and quantities.
5. Actions: Engineer will return submittals with one of the following actions:

NO EXCEPTIONS TAKEN	Contractor may proceed with the work as submitted
EXCEPTIONS AS NOTED	Contractor may proceed with the work and without resubmittal provided he complies with all exceptions noted in the submittal, and so states in a letter
REVISE AND RESUBMIT	Resubmit in accordance with the indicated comments
REJECTED	Resubmit in accordance with the contract documents
RETURNED WITHOUT ACTION	This submittal has not been reviewed, and therefore the Engineer is returning it with no direction to the Contractor.

E. Substitutions:

1. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or if any work is installed in a manner which is not in conformance with the requirements of this specification and for which the Contractor has not received written authorization, remove such unauthorized work and install work in accordance with the contract documents at no change in contract amount.
2. Authorized Substitutions: Provide all accessories and features as required and coordinate substitutions with other disciplines. Bear any extra expenses resulting from the use of substitutions which affect adjoining or related work required in this division or other divisions of the work.
3. If the Contractor substitutes equipment for that indicated on the drawings, he shall prepare a 1/4 inch = 1foot installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will properly fit within the space with adequate clearance for maintenance and replacement. Submit this drawing for review.

F. Schedule: Submit all submittals in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time. Be aware that

there is risk in ordering components, fabricating work, and/or installing work prior to review. If the Contractor proceeds prior to review, and then the review comments required modifications to work which has begun or has been completed, then Contractor must comply with the review comments at no change in contract amount or schedule.

G. Shop Drawings

1. Submit shop drawings for

    a. Mechanical equipment rooms and other spaces housing air handling equipment, heat transfer equipment, fluid handling equipment, machinery, etc.
    b. Complete supply, return, and exhaust ductwork systems, both exposed and concealed.
    c. Piping for HVAC, plumbing, and fire protection systems, both exposed and concealed.

2. Show the location and elevation of all equipment, ductwork and piping, as well as openings through slabs and walls. Include plans, elevations and sections as appropriate. Clearly show the manner in which the systems fit into the available space and relate to each other and to the building elements. Indicate required sleeves and openings in general construction elements. Indicate required clearances for operation, maintenance and replacement of operating devices and equipment. Drawings shall be of appropriate scale to facilitate coordination and understanding, but not smaller than 1/4 inch scale for floor plans and 1/4 inch scale for equipment rooms and chases.
3. Conflicts: The engineer has endeavored to work out conflicts in areas where the design is congested, but has not tried to show all required offsets to coordinate with the building construction and building systems, particularly in less congested areas. The intent is that the Contractor coordinate the design of the piping and ductwork distribution systems with the building construction and the various building systems, particularly in less congested areas. Provide experienced designers to perform such services and prepare shop drawings. Exercise good design practice in working out conflicts without compromising system operation or maintenance. Provide fittings, offsets, etc., as required. Contractor shall include this design effort and include the labor and materials for such fittings and offsets in his base bid. Except in extremely unusual circumstances, no additional costs will be allowed related to working out conflicts. Coordinate with other disciplines as required. Identify on the shop drawings those areas where redesign was necessary to resolve design conflicts.

    a. In the event that the Contractor desires direction in resolving a design conflict or desires prior approval of a recommended approach to resolving a conflict, submit an RFI which identifies the conflict and suggests a recommended solution.
    b. In resolving conflicts, gravity lines and larger distribution mains will generally have priority over pressurized lines and smaller lines as follows:

        Plumbing waste and vent lines
        Roof drains
        Supply, return and exhaust ductwork
        Fire sprinkler mains
        Domestic hot and cold water
        Fire sprinkler branch piping and sprinkler runouts
        Miscellaneous special piping systems

4. Use of Engineer's CADD Files or BIM model: The Engineer will provide the Contractor CADD files or a BIM model of the design documents if the Contractor completes and submits the release form attached at the end of this spec section. These files show the general design intent and may be used as a starting point for the Contractor to begin his shop drawings and coordination effort, but the Contractor should not use them as a basis for ordering or fabrication. The normal submittal process still applies, regardless whether the Contractor elects to use the Engineer's CADD files or BIM model.

H. Submittals Required under this Specification Section:

1. Electrical Components: Motors, Motor Controllers, and Variable Speed Drives

I. Identification: Products used to identify equipment, ductwork, valves, piping, and control devices.

1. General Construction Components: Roof Curbs & Access doors.

1.9 DOCUMENTED COORDINATION EFFORT

A. After shop drawings are reviewed, incorporate any review comments and then participate in a formal and documented coordination effort with the contractors and subcontractors for other divisions of the work. Show all piping systems and equipment on the ductwork drawings, and send electronic CADD files to the General Contractor and the subcontractors for plumbing, fire protection, electrical, and other disciplines. The other subcontractors will then add their work to the CADD files.

B. Make full-size plots of the drawings. Participate in meetings with the GC and other subcontractors to review each area, identify conflicts, and resolve conflicts. Submit the resolutions to the Engineer for review. Maintain adequate space for operation, maintenance, and code-required clearances. Ensure that all subcontractors initial each plan to indicate that they have participated in the coordination effort.

1.10 MISCELLANEOUS PROVISIONS

A. Qualifications

1. All mechanics shall be skilled in their respective trade.
2. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

B. Regulated Materials: Comply with all state, local and federal regulations regarding the storage, handling or disposal of oils, lubricants, cleaning agents, refrigerants, other liquids and gases, and hazardous materials.

C. Factory Identification: Provide all materials and equipment with labels sufficient to show compliance with these specifications and the performance requirements indicated on the drawings. All equipment shall carry a permanent label installed by the manufacturer stating that the equipment complies with ASHRAE/IESNA Std. 90.1.

D. Hazardous Conditions: Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

E. Hazard Signs

1. Provide a sign reading, "Hazardous Area - Authorized Personnel Only" on the doors to all equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments.
2. Provide a sign reading, "Confined Space - Entry by authorized personnel only by permit" for all confined spaces. Confined spaces shall be as designated by OSHA Standard 1910.146. This generally means a space that:

    a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
    b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
    c. Is not designed for continuous employee occupancy.

3. Survey the final premises to determine where any potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.11 GUARANTEE-WARRANTY

A. See Division 1 for additional information on warranties. Warranties shall run for one year from substantial completion unless indicated otherwise.

B. The following warranty shall be binding:

> "The Contractor warrants that this installation is free from mechanical defects. Contractor agrees to replace or repair any part of the installation which may fail within a period of one year after the date established below, provided that such failure is due to defects in materials or workmanship, or to failure to follow the specifications and drawings. This warranty shall begin on the date set forth in the Certificate of Substantial Completion, AIA Form G704, or other such date as documented in writing by the Owner's Representative."

C. The extent of guarantees or warranties by equipment and/or materials manufacturers will not diminish the requirements of the Contractor's warranty to the Owner.

PART 2 - PRODUCTS

2.1 PRODUCT GENERAL REQUIREMENTS

A. General: Products supplied under Division 23 shall comply with the following except as noted

elsewhere.

B. Products shall be new; shall be the product of manufacturers regularly engaged in the production of plumbing, heating, ventilating, air conditioning, and control system equipment; and shall be the manufacturer's latest design. Specs and equipment schedules establish expectations regarding standard of quality and operating intent.

C. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

D. Products shall be suitable for the conditions under which they are installed and operated. Prior to or during the submittal phase advise the Owner’s representative and the Engineer in writing regarding any concerns about the suitability of the specified products for the intended application or service. Request clarification if any question exists regarding the design intent.

E. Performance Ratings: Unless otherwise noted, all scheduled equipment performance is based on an elevation of 7410 feet above sea level. Adjust manufacturer's ratings accordingly.

F. Structural Soundness: Products shall have structural integrity appropriate to the component and its application. Bases shall be rigid and shall keep all components in proper alignment. Structural integrity shall be adequate for both rigging and final installation. Components shall not be loose, rattle, or vibrate unnecessarily in their final installed condition.

G. Corrosion Resistance: Equipment shall be of materials inherently corrosion resistant, or shall be finished with a corrosion-resistant finish suitable for the location in which the equipment is installed.

H. Touch-up: If the factory finish of any component is damaged prior to substantial completion, touch up to original condition per manufacturer’s recommendations.

I. Equipment Access Doors or Panels: Provide access doors and panels within equipment to ensure good access to all components requiring inspection, service or maintenance. Provide appropriate hardware. Equipment installed outdoors shall be weather-tight.

J. Fans: Statically and dynamically balanced, shaft first critical speed shall be above operating speed at design conditions.

K. Bearings: Grease lubricated or permanently lubricated.

L. V-Belt Drives: All components sized for 150% of motor HP, multiple belts shall be matched, fixed sheaves for motors 20 Hp and larger, adjustable sheaves for lower HP motors, all safety components for OSHA compliance (e.g., belt guard or other safety provisions) motor mounted on adjustable base. Provide a replacement sheave for each fixed sheave after T&B is complete. Include belt data in O&M manual. Gates Rubber Co, or approved equal.

1. Belt Guards: Rigidly constructed and attached, removable, galvanized steel, expanded mesh. Design to provide ready access to bearings.

M. Couplings: Provide coupling guard.

N. Motors and VFDs: See requirements described elsewhere in this spec section.

O. Drive Lines (starter or VFD, motor, coupling and shaft or v-belt drive and pulleys, and driven equipment): Coordinate with all suppliers and ensure all components are compatible to work as a system.

P. Coils: ARI rated, copper tubes mechanically expanded into aluminum fins, galvanized steel casing, drainable, pressure tested to 150% of working pressure but not less than 300 psi.

Q. Cooling Coil Drain Pans: Provide for all cooling coils, galvanized or stainless steel, double pitched with piped outlet. For units with more than one coil stacked, provide intermediate drain pans piped to the main drain pan.

R. Gas Burners: Natural gas fired, performance based on gas at 1000 Btu/SCF HHV but suitable for use with gas at 900 – 1050 Btu/SCF and 7 – 11 inches water column, factory installed and pressure tested gas train, all necessary safety and operating controls.

S. Filter Frames: Galvanized steel, provide wherever filters are specified.

T. Roof Curbs and Support Rails for Roof-Mounted Equipment: Roof curbs should generally be supplied with the equipment which the curb supports, and shall comply with the requirements of the National Roofing Contractors' Association. Match curb to the requirements of the supported equipment. The roof pitch is indicated on the architectural drawings. If roof pitch exceeds the recommendations of the equipment manufacturer, provide a curb that will level the equipment. Factory fabricated, minimum 14-inch, structurally adequate for the load supported, not less than welded 18-gauge (16-gauge or heavier for sizes more than 50-inches) galvanized steel with minimum 1-inch fiberglass insulation, 2 x 2 wood nailer, and with cant and step if required to match specified roof. Provide damper tray for un-ducted fan applications. Ship small curbs fully assembled; large curbs may be knocked down for shipment.

U. Electrical & Controls: Except where specifically noted, electric service to each component listed on the equipment schedules will be through a single electrical feed at the voltage indicated on the equipment schedules. Include all components, cabling and conduits to distribute power to all components which are factory supplied and mounted. Provide transformer(s) if required to serve unit-mounted components requiring electric service at voltages different from the main electric service, including controls components. Provide secondary overcurrent protection. Provide terminal strips for field-installed control wiring. Provide unit-mounted, unit-specific wiring diagrams on durable paper, attached to inside of control panel door or otherwise affixed to the unit. All electrical components shall be UL Listed or Recognized. All factory-installed electrical work shall comply with the NEC unless the overall unit is listed by an organization acceptable to the AHJ, and listed to a standard acceptable to the AHJ.

2.2 ELECTRICAL COMPONENTS

A. General: Except as noted, all electrical products and equipment shall comply with the requirements of this section, whether field installed or factory installed. See "Product General Requirements" and "Installation General Requirements" in Parts 2 & 3 of this spec section for additional requirements.

B. Motors

1. General: Except as noted motors shall be horizontal, open drip-proof, 4-pole, 1750 RPM, rated per NEMA MG-1, with fabricated steel or cast iron casing, motor terminal box adequately sized for conductors one-size larger than specified, SS nameplate per NEMA MG-1-20.60, connection diagram attached to motor, compression lugs for power feeds and ground conductor, grease lubricated sealed ball bearings or roller bearings with standard grease fitting zerk and relief tapping, factory lubricated, dynamically balanced to no more than 50% of the NEMA allowable vibration limits. For motors powering V-belt drives, provide a cast iron or steel base with slide rail and adjustable belt tension device. Install motors and equipment on foundations and align as required. 40 deg C rise and total temperature rise of 65 deg C ambient.

   a. 3/4 hp and smaller: 115V, single phase, 60 Hz, split phase or permanent split capacitor (PSC), NEMA Type N or O, with built-in thermal overload protection.
      1) Multi-speed motors.
   b. 1 hp and greater: 460 V, 3 phase, 60 Hz, squirrel cage induction type, NEMA design B, T-frame, with Class B or F insulation, lifting lugs, 150,000 hr L-10 bearings for direct-coupled applications, 50,000 hr L-10 bearings for belt-driven application with radial loads and pulley sizes per NEMA MG1-14.43. Service Factor: ODP motors shall be rated for 1.15 SF at 40ºC or 1.0 SF at 65ºC; TEFC motors shall be 1.0 SF.
      1) Two speed motors: Provide with two separate windings.
      2) Variable speed motors: Drive compatible per NEMA MG1-31, premium efficiency as specified below regardless of Hp, Class F insulation, minimum 5-year warranty.

2. Efficiency: Except as noted, motors shall be premium efficiency type, with nominal efficiencies not less than the following as per the Consortium on Energy Efficiency (CEE), and minimum power factor of 0.85:

	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
HP	1200 RPM	1800 RPM	3600 RPM	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7

3. Approved Manufacturers: General Electric Energy Saver, Baldor Super-E, Marathon Series E, Reliance Electric XE, Westinghouse TEE II, Eaton/Cutler Hammer, Toshiba, Louis Allis, or approved equal.
4. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with all other parties (e.g. electrical contractor) and pay any costs associated with the change.

C. Motor Controllers

1. Single Phase Manual Starters to 1 Hp and 120-277 V: Cutler Hammer MS with indicating light.
2. 3-Phase: Full voltage, non-reversing, electro-mechanical, combination circuit breaker and motor controller, UL Listed, NEMA rated, 460V, 65,000 AIC, minimum 50 VA 24V controls transformer with secondary overcurrent protection, suitable for operation at -4°F to +149°F and specified voltage -15% to + 10%, adjustable solid state overloads initially set at Class 10, HOA switch, run indicator, two auxiliary contacts for remote monitoring of status, and enclosure for surface mounting. Cutler Hammer OAE.

    a. Provide enclosure appropriate to the location:
        1) NEMA-1 for indoor dry locations.
        2) NEMA-3R for outdoors.
        3) NEMA-4 for wet applications.
        4) NEMA-12 for dusty locations.
        5) Explosion-proof – where required.
    b. Motor controllers factory mounted and wired on AC units, boilers, etc, may be definite purpose, and need not have all the features specified here.

2.3 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. Provide wiring and conduit as scheduled in Section 23 0549.

B. Coordinate with all disciplines to ensure that all necessary components of control work are included and fully understood.

2.4 IDENTIFICATION

A. Scope: Identify all equipment, ductwork, valves, piping, and control devices shown on the Drawings, identified in the equipment schedules, and indicated in these Specifications. Provide submittals for products and procedures used for identification.

B. Equipment: For all mechanical equipment supplied or installed under Division 23, provide an equipment identification tag or stencil unit number onto the equipment. Stencils shall be minimum 3-inch height, dark contrasting color, of a material suitable for the application.

1. For rooftop HVAC equipment, provide a permanently affixed, weather-resistant label to identify the areas served.

C. Valves: Provide each valve with a stamped metal tag secured to the valve. Tag shall indicate the valve number, service and function. Provide two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Drawings shall be neat and easily readable. Provide a typed valve chart, listing the valve number, size, location, function, normal operating position, for each valve. List valves by system, i.e., domestic cold water, hot water, chilled water, etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

D. Ductwork: Identify ductwork at or near the fan with stenciled signs on insulated ductwork or engraved laminated plastic signs secured by rustproof screws on un-insulated ductwork. Sign shall identify air conditioning system or fan unit and area served.

E. Piping

1. Provide color-coded pipe labels indicating the service of the pipe and the direction of flow. Piping labels shall comply with ANSI Standard A13.1 regarding color coding and size of lettering. The following standardized color code scheme shall be used:

   a. Yellow - Hazardous Materials.
   b. Green - Liquid Materials of Inherently Low Hazard.
   c. Blue - Gaseous Materials of Inherently Low Hazard.
   d. Red - Fire Protection Materials.

2. Labels shall be semi-rigid plastic identification markers. Labels shall "span-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4 inch through 5 inches. Labels for piping 6 inches and larger shall be furnished with spring attachment at each end of label. "SETMARK" Type SNA, 3/4 inch through 5 inch size and Type STR, 6 inches and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.
3. Labels shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.
4. For retrofit projects the system names shall match existing.
5. Attach pipe markers to lower quarter of the pipe on overhead horizontal runs and on the centerline of vertical piping where view is not obstructed.
6. Provide the following labels, with ANSI/OSHA color and banding for all piping systems as shown on the Drawings and as listed below:

Service/Legend	Letter Color	Background Color	Tape Banding Color
Domestic Cold Water	White	Green	2" Green
Domestic Hot Water	Black	Yellow	2" Yellow
Domestic Hot Water Return	Black	Yellow	2" Yellow
Fire Protection Water	White	Red	2" Red
Fire Auto Sprinkler	White	Red	2" Red
Fire Dry Standpipe	White	Red	2" Red
Fire Wet Standpipe	White	Red	2" Red
Fire Comb. Standpipe	White	Red	2" Red
Roof Drain	White	Green	2" Green
Sanitary Sewer	White	Green	2" Green
Storm Sewer	White	Green	2" Green
Natural Gas	Black	Yellow	2" Black

7. Locations: Label pipes at the following points on each piping system:

    a. Adjacent to each valve in piping system.
    b. At every point of entry and exit where piping passes through a wall.
    c. On each pipe riser and junction.
    d. At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
    e. Adjacent to all special fittings (regulating valves, etc.) in piping systems.
    f. At every access door.

8. Underground Piping: Provide a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6 inches to 8 inches below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type.

F. Control System Devices: All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the Contract Drawings.

2.5 GENERAL CONSTRUCTION COMPONENTS

A. Roof Curbs and Equipment Support Rails

1. General: Factory fabricated, minimum 14-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction.
2. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, RPS, OAE.
3. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck, RPS, OAE.

B. Access Doors (ADs)

1. Access Doors by Div 08. Coordinate location of Access Doors with Division 08. Refer to Specification Section 08 3113.

2.6 MISCELLANEOUS PROVISIONS

A. Flow Diagrams: Provide half-size prints of each system flow diagram, including air handling, steam, chilled water, heating water, domestic water, domestic HW, etc. Mount framed under plexiglass, and locate either on the associated AHU or on a nearby wall. Incorporate any as-built revisions.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL REQUIRMENTS

A. Cooperation with Other Trades: Refer to other parts of these Specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. Be responsible for the size and location of all openings, foundations, etc.

B. Trenching and Backfilling: Provide all excavation, trenching and backfilling required for the installation of the work of this division.

C. Manufacturer's Instructions: Install all products in accordance with manufacturers' recommendations and the requirements of any applicable listings. If manufacturers' recommendations and/or requirements of applicable listings conflict with plans and specifications, report such conflicts to the Owner's Representative.

D. Field Measurements: Verify all dimensions and conditions governing the work. Examine adjoining work on which the work of this Division is dependent, and report any deficiencies.

E. Do not compromise the building structural, fire resistant construction or vapor barrier system. Supports for Equipment and Systems: Foundations and structural supports for equipment will generally be provided by others. The contractor for this division shall provide supplementary supports as required to support equipment, distribution systems, and other components installed under this division. Prior to installing mechanical work, examine foundations and supports to ensure they are adequate to properly support the equipment. Provide all necessary foundations, structures, supports, inserts, sleeves, etc, for installation of mechanical and plumbing equipment, ductwork and piping, etc. Coordinate installation of such devices with all disciplines. Verify that the devices and supports are adequate as intended and do not overload the building structure.

F. Concealed or Buried Work: For work which is underground or which will be concealed by building construction, provide digital photographs to document the installation throughout the construction project, but not less than weekly. Include plans indicating where the photographs were taken. Notify the OR of when the work will be complete and provide OR a minimum five-day period to inspect the work after completion but prior to when it is backfilled or concealed by building construction.

G. Access Doors: Provide as required for access to valves, dampers, controls, or other items for which access is required for either operation or servicing. The type of access door shall be as required by the room finish schedule.

H. Alignment of Flexible Couplings: Flexible couplings between motors and driven equipment shall be aligned by a qualified service technician after the equipment is installed and ready for operation. Align equipment per manufacturer's recommendations under operating conditions and temperature. Provide written certification that each device has been so aligned.

I. Lubrication: Provide all oil for the operation of all equipment until acceptance. Be responsible for all damage to bearings while the equipment is being operated by Contractor up to the date of

acceptance of the equipment. Protect all bearings and shafts during installation and thoroughly grease shafts to prevent corrosion. Bearings for items of mechanical equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

J. Tests: All tests shall be conducted in the presence of the designated and authorized Owner's Representative. Notify the Owner's one week in advance of all tests. Requirements for testing are specified under the sections covering the various systems. Provide all necessary equipment, materials, and labor to perform the required tests.

K. Protection of Material and Equipment:

1. Protect all work, materials and equipment furnished and installed under Division 23, whether incorporated in the building or not.
2. All items of mechanical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner as approved.
3. Protect all work and be responsible for all damage done to property, equipment and materials. Coordinate material storage with the Owner's Representative.
4. Pipe and duct openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. Plumbing fixtures shall not be used by the construction forces. At the completion of the work clean and polish fixtures, equipment and materials prior to turning them over to the Owner.

3.2 DRAWINGS

A. The drawings show the general arrangement of the piping, ductwork, equipment, etc. Follow them as closely as actual building construction and work of other trades will permit. Where discrepancies occur between Plans and Specifications, the more stringent shall govern. All Contract Documents shall be considered as part of the work. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories, which may be required, and no attempt has been made to do so. Rather, the drawings convey the general design intent. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing fittings, valves, and accessories as required to meet such conditions. Show any such changes on the Record Drawings.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, submit an RFI.

C. Install equipment, piping, ductwork, and electrical systems with proper clearance for operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions, etc. Include proper clearance in front of and above electrical equipment as defined by the National Electric Code (NEC). Piping and ductwork systems shall not be routed through or above electrical equipment rooms, telecommunications rooms, elevator machine rooms, or electrical equipment spaces within mechanical equipment rooms.

D. The unique design features of this project will necessitate that the contractor for this division provide greater than normal levels of coordination and cooperation with other disciplines.

E. Arrange all concealed mechanical systems carefully to fit within the available space without

interference with adjacent structural and electrical systems. Make all necessary provisions for penetrations of piping and ductwork, including sleeves and blockouts in structural systems. The exact location of all exposed mechanical systems, including grilles, registers, and diffusers; access doors; sprinkler heads; piping and ductwork exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it relates to the aesthetic design for the facility.

3.3 EQUIPMENT SUPPLIED BY OTHERS

A. Certain items of mechanical equipment as listed on the Drawings and/or Specifications will be furnished [under other sections of this Specification for mechanical rough-in and connection under Division 23, including plumbing, domestic water and waste, process cooling water, compressed air, exhaust, etc. All required mechanical services, including connection of such services to equipment shall be provided under Division 23.

3.4 INTERRUPTING SERVICES

A. Coordinate the installation of all work within the building in order to minimize interference with the operation of existing building mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

3.5 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of mechanical equipment unless specifically deleted by the Specifications or Drawings.

B. Be responsible for the accurate dimensions of all pads and bases and furnish and install all vibration isolators, anchor bolts, etc.

C. Provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the Drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these Specifications. Pad foundations shall be 4 inches high minimum, unless otherwise indicated on the Drawings. Chamfer edges shall be 1 inch. Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1 inch larger than bolt diameter. Anchor bolts shall be high strength steel J-shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, and then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before

the machinery base is grouted.

3.6 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

3.7 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the installation for the equipment listed below. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

Domestic Hot Water Heaters
Roof Top Units
Facility Management System (See Specification Section 23 0900)

3.8 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems for the benefit of the Owner prior to substantial completion will be allowed provided that a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems for the benefit of the Contractor, except for the purposes of testing and balancing, will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.9 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. At completion of the project provide two complete bound sets of the following documents, along with two CDs containing searchable PDFs of these documents. Organize bound information in a logical fashion with a table of contents and tabs for the different sections.

Organize PDFs in a logical fashion with bookmarks to assist the operating personnel in retrieving desired data. Provide minimum two 1-hour sessions to instruct Owner's facility personnel in how to find information in the bound O&Ms and the PDFs. Take attendance and submit the attendance list to the Owner's Representative. Include the following:

1. Approved Submittals.
2. Test reports.
3. O&M manuals and instructions covering all equipment supplied under this Division, with all non-applicable information crossed out. Clearly identify all required routine maintenance. Include parts lists.
4. A master Lubrication Chart listing each piece of equipment, the recommended oil or grease, and the recommended frequency of lubrication.
5. The names and addresses of at least one service agency capable of providing required maintenance for each item of equipment supplied.
6. Complete temperature control diagrams including control descriptions, system sequence of operation, operating instructions, control system maintenance and calibration information, wiring diagrams, and all control setpoints. See Section 23 0900 for additional requirements.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Submit O&M manuals for review and distribution to the Owner not less than two weeks prior to the date scheduled for O&M instructions as specified.

D. Demonstrate proper system operation to the owner's operating staff. Provide the services of the contractor and subcontractors (e.g., mechanical, T&B, temperature control, etc), as required to properly demonstrate system operation.

E. Provide the necessary skilled labor and helpers to operate the mechanical systems and equipment for a period of 5 days of eight hours each. During this period, instruct the owner’s facility staff fully in the operations, adjustment and maintenance of all equipment provided. Provide at least two weeks advanced notice, with a written schedule of each training session, the subject of the session, the Contractors' Representatives who plan to attend the session, and the time for each session. Take attendance and submit attendance sheets to the Owner's Representative.

3.10 RECORD DRAWINGS

A. See Division 1, for additional requirements associated with Project Record Drawings.

B. Maintain a full-size set of marked-up prints showing the installed location and arrangement of all work under this division, and in particular where changes were made during construction. Keep record drawings accurate and up-to-date throughout the construction period. Owner’s Agents may request to review record drawings during construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFIs, bulletins, and change orders neatly taped or attached to record drawing set. At the completion of the project send the Engineer full-size plans clearly showing all changes from the original design marked up in red so as to facilitate the Engineer incorporating these changes into the Engineer’s CADD files. Forward record drawings to the Owner's Representative prior to submitting a

request for substantial completion.

3.11 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Engineer may make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the work so as to determine if such work is proceeding in general accordance with the Contract Documents. This observation will not release the Contractor from his responsibility to supervise, direct, and control all construction work and activities. The Engineer has no authority over, or responsibility for means, methods, techniques, sequences, or procedures of construction or for safety precautions and programs, or for failure of the Contractor to comply with applicable laws, regulations, or codes.

B. Prior to substantial completion, request that the Engineer provide a final observation visit. Complete the attached "Final Observation Checklist," and include it with this request. For any items that are not applicable, mark them "N/A."

3.12 PROJECT CLOSEOUT

A. Submit written certification that all work complies with the specifications and applicable codes. Submit certifications and acceptance certificates including proof of delivery of record drawings, O&M manuals, spare parts required, and equipment warranties.

END OF SECTION 230500

Project:_____ Date Submitted:_____

General Contractor:_____ Date of Final Mechanical System:_____

Mechanical Contractor:_____ Observation Requested:_____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

PLUMBING/PIPING

_____1. All plumbing fixtures are set, sealed and cleaned.

_____2. All domestic and HVAC pipe systems are insulated.

_____3. All pipe systems are identified with specified labels and directional arrows.

_____4. Floor sinks and drain grates are cleaned and debris removed.

_____5. Valve tags are installed.

_____6. Special equipment (water softeners, water heaters, piping systems, etc.,) have been checked and put into service.

_____7. Medical gas systems have been checked and certified.

_____8. Special piping systems have been cleaned and pressure tested.

_____ Fuel Handling
_____ Compressed Air
_____ Natural Gas
_____ Other

_____ Process Piping
_____ Nitrogen
_____ Vacuum
_____ Argon
_____ Medical Gas
_____ Other

_____9. Limestone chips have been installed in acid dilution sumps.

_____10. Plumbing/piping connections have been completed to Owner-furnished equipment and equipment furnished by other Contractors/Subcontractors.

_____11. Exterior wall hydrants have been cleaned.

_____12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.

_____13. Drains and relief lines from plumbing and HVAC equipment have been installed and secured in a proper manner.

_____14. All plumbing equipment and areas of equipment have been cleaned and debris removed.

_____15. All plumbing equipment required by the Specifications has been identified and/or numbered.

_____16. Domestic water systems sterilization has been completed.

_____17. Refrigerant piping/system has been charged and tested.

_____18. Strainers/suction diffusers have been cleaned.

_____19. Backflow preventers have been tested.

_____20. Air has been vented from all coils and systems.

_____21. Water treatment systems have been charged and tested.

_____ Chilled Water
_____ Hot Water
_____ Condenser Water
_____ Steam/Condensate

_____22. Ethylene glycol system has been charged with correct mixture and tested.

_____23. Water systems have been cleaned (X) and pressure tested (P)

_____ Chilled Water
_____ Hot Water
_____ Steam
_____ Condensate
_____ Fire Protection
_____ Sanitary Sewer and Vent
_____ Roof and Overflow Drains
_____ Condenser Water
_____ Non-potable Water
_____ Domestic Hot Water
_____ Domestic Cold Water
_____ Acid Waste and Vent
_____ Heat Recovery Piping
_____ Other (list)

_____24. PRVs have been adjusted (water, steam, gases).

FIRE PROTECTION

_____1. Fire protection piping is completed.

_____2. Fire protection system has been certified by the Fire Marshal's office.

_____3. All electrical interlocks between the fire sprinkler components and the fire panel have been checked for operation.

_____4. Spare sprinkler head, wrench and cabinet are installed.

HVAC - EQUIPMENT AND DUCTWORK

_____1. All ductwork has been sealed and insulated.

_____2. Return air paths and transfer openings have been verified.

_____3. Air handlers have been cleaned inside and out and construction filters removed and replaced with final filters.

_____4. All air handling equipment has been started and operated for the specified time.

_____5. All equipment isolators have been adjusted for specified deflection.

_____6. All VAV boxes, fan coils, or fan powered boxes are completed and operational.

_____7. All pump shafts and couplings have been aligned.

_____8. Ductwork, coils, housing, diffusers, registers and grilles have been cleaned.

_____9. Boilers have been fired and certified by the supplier.

_____10. Cooling towers have been started and inspected by the supplier.

_____11. Chillers have been charged, started and certified for operation by the supplier.

_____12. Fire dampers are accessible and fully operational.

_____13. All HVAC equipment has been lubricated.

_____14. HVAC equipment has been labeled in accordance with the Specifications.

_____15. Duct pressure testing is complete and accepted.

_____16. "HAZARDOUS AREA" signs installed where applicable.

_____17. Belt guards installed where applicable.

_____18. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

_____19. Testing and balancing has been completed, and deficiencies noted have been corrected.

_____20. Special systems have been started and tested, such as: Humidification, laboratory hoods, kitchen hoods, and Owner-furnished items.

TEMPERATURE CONTROLS

_____1. Temperature control panels and devices have been labeled in accordance with the Specifications.

_____2. All control dampers close completely and edge and blade seals form tight seal.

_____3. All control valves have been piped as required by the Drawings.

_____4. Controls systems are completed and all control points are operating and recording properly.

_____5. All temperature control tubing and wiring is installed and secured in accordance with the Specifications and the electrical code.

_____6. Smoke removal fans and/or smoke detectors have been tested for operation and shutdown.

_____7. Freezestats have been tested ensuring fan shutdown and full damper closure.

_____8. Operator training for temperature controls has taken place.

_____9. Refrigerant sensors and equipment room shutdown have been tested.

GENERAL ITEMS

The following specified items have been submitted:

_____1. Record Drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 23 0500).

_____4. Testing and balancing reports.

_____5. Test kits furnished to Owner.

_____ Flow Measuring Devices
_____ Flow Balance Valves
_____ Flow Control Devices

_____6. Temperature control schematics and sequence of operation.

_____7. Wall-mounted lubrication, valve, and temperature control charts have been installed.

DIVISION 23 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:
Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____
Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain: _____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only

Accepted _____ Not Accepted _____ Received Too Late _____
By: _____ Date: _____
Remarks: _____

CADD DATABASE LICENSE, INDEMNITY AND WARRANTY AGREEMENT

PROJECT: _____

LICENSE

1.1 LICENSE GRANT: Contractor is granted use of the CADD Database for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the CADD Database is granted. Title to the CADD Database is not transferred to the Contractor.

1.2 COPYING RESTRICTIONS: Contractor may copy the CADD Database in whole or in part, but only for backup and archival purposes and for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities who receive a copy of the CADD Database from Contractor, either in whole or in part, comply with the terms and conditions of this agreement.

1.3 TRANSFER OF CADD DATABASE: Contractor safeguard the CADD Database from falling into the hands of any parties other than those indicated in Section 1.2 of this Agreement.

WARRANTY

2.1 DATABASE WARRANTY: Bridgers & Paxton (B&P) disclaims all warranties with regard to the database, including all implied warranties of fitness. B&P disclaims all obligations or liabilities for damages, including but not limited to, consequential damages rising out of or in connection with the use or performance of the database.

INDEMNITY

3.1 INDEMNITY: Contractor recognizes that the use of the database will be at the Contractor's sole risk and without any liability, risk or legal exposure by B&P. It shall be the Contractor's sole responsibility to verify dimensions in the drawings prior to using these database files for his intended purpose. Furthermore, the Contractor shall, to the fullest extent permitted by law, defend, indemnify and hold harmless Bridgers & Paxton from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the database.

ACKNOWLEDGMENT

4.1 ACKNOWLEDGMENT: The Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 230504 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 23, shall be lead free. The term lead free is defined as pipe which does not contain more than 8.0% lead and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Piping system materials shall be furnished as specified under the Sections describing the various piping systems. Pipe fittings shall be compatible with the piping systems in which they are installed.

B. Pipe fittings for steel piping systems shall be weld, screwed or mechanical couplings. Butt weld fittings shall be manufactured by Weld-Bend, Laddish, or equivalent, standard or extra strong as specified in the applicable Sections of this Specification, conforming to ANSI Standard B16.9. All 90^0 weld elbows shall be long radius unless otherwise specified. Wherever tee connections are required in the piping system, manufacturer's straight or reducing tees shall be utilized. The use of fittings formed from welded pipe or pipe sections will not be permitted. Forged steel "Weld-O-Lets", "Branch-O-Lets", and "Thred-O-Lets", as manufactured by Bonney Forge or equivalent, may be utilized for welded branch and tap connections up to one-half the size of the main. Forged steel half-couplings conforming to ANSI B16.11 may be used for drain, vent and gauge connections. Flanges shall be forged steel weld neck or slip-on, raised face, Class 150 or 300 as specified in the applicable Sections of this Specification with full face or ring type non-asbestos gasket material suitable for the application.

C. Socket weld fittings shall be Schedule 40, 2000 pound or Schedule 80, 3000 pound construction, as specified in the applicable Sections of this Specification, conforming to ANSI B16.11, as manufactured by Grinnell or equivalent.

D. Screwed fittings shall be Class 150 standard or Class 300 extra heavy, black or galvanized, malleable iron or cast iron, as specified in the applicable Sections of this Specification, as manufactured by Grinnell or equivalent. Screwed malleable iron fittings shall conform to ANSI B16.3 and cast iron screwed fittings shall conform to ANSI B16.4. Bushing reduction of a single pipe size or use of close nipples will be permitted.

E. Pipe couplings and fittings as manufactured by Victaulic, Tyco-Grinnell, or equivalent may be utilized for steel piping systems in lieu of butt weld fittings, as specified in the applicable Sections of this Specification. Couplings shall consist of ductile or malleable iron housing, with gasket, and nuts and bolts required to secure the unit. Gaskets shall be molded of synthetic rubber or other compound as recommended by the manufacturer for the fluid application including required pressure and temperature operating ranges. Fittings utilized in conjunction with Victaulic type piping system shall be manufacturer's full flow cast iron, malleable iron, or steel fittings with grooves designed to accept mechanical couplings. All piping shall be prepared in accordance with manufacturer's specifications, furnished for factory or field installed roll grooves without metal removal. Square cut grooves will not be permitted. Assembly of couplings, fittings and piping shall be in accordance with manufacturer's published instructions. Gaskets, pipe ends, fittings and coupling housings shall be properly lubricated with water-based type lubricant furnished by the coupling manufacturer. Couplings shall be Victaulic Style 07 "Zero-Flex" or equivalent, rigid coupling through 24" size. For applications in conjunction with connections to items of equipment such as boilers, water chillers, cooling towers, etc., Victaulic Style 75 or equivalent couplings shall be utilized. Adapter connections between Class 125 and 150 flanged components and grooved piping system shall be made utilizing Victaulic Style 741 and 742 or equivalent flange adapter. Branch and tap connections up to one-half the size of the main may be made utilizing Victaulic Style 72 or equivalent outlet couplings and Style 920 or 921 or equivalent branch outlet connections.

F. Pipe fittings for copper piping system shall be wrought copper conforming to ANSI B16.22. Cast brass fittings conforming to ANSI B16.23, may be utilized for sanitary drainage, waste and vent systems, HVAC gravity condensate drainage system, and other non-pressure applications.

G. Bronze flanges, Class 125 and Class 150, shall conform to ANSI B16.24.

H. Cast iron fittings for cast iron sanitary soil, waste, and venting piping systems shall be as specified in Division 22.

I. Ductile iron fittings for ductile iron water service piping systems shall be as specified in Division 22.

J. Fittings for special piping systems including acid resistant waste and vent systems, high purity water distribution systems, PVC piping systems, shall be compatible with the piping system requirements and shall be as specified in Division 22.

2.2 FLOOR, WALL AND CEILING PLATES

A. Where uncovered, exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass escutcheon plates. Plates shall be large enough to completely close the hole around the pipe, and shall be not less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.3 UNIONS

A. Piping 2-1/2" and larger shall be provided with bolted flange union connections. Weld flanges and bolting shall conform to ANSI B16.5. Bronze flanges shall conform to ANSI B16.24. Flange class shall be as specified in the applicable Sections of the Specifications.

B. Malleable iron grooved joint unions with brass to iron seats, Class 125, 250, or 300, as required by the application and compatibility requirements with the piping system fitting classification, conforming to MSS SP-77 and ANSI B16.39, shall be provided in piping systems 2" and smaller. Copper unions conforming to ANSI B16.22 shall be provided in copper piping systems. Union connections shall be installed at all coils, control valves, equipment connections, and at other locations shown on the drawings, and required for proper system operation and maintenance.

2.4 DIELECTRIC FITTINGS

A. Dielectric insulating fittings shall be provided to connect dissimilar metals, such as copper tubing to ferrous metal pipe. Connections 2" and smaller shall be threaded dielectric union conforming to ANSI B16.39. Connections 2-1/2" and larger shall be flange union with dielectric gasket and bolt sleeves, conforming to ANSI B16.42. Insulating fittings will not be required between bronze valves and copper piping, unless otherwise specified.

2.5 PIPE HANGERS AND SUPPORTS

A. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications. Pipe hangers shall be Grinnell, B-Line, Erico, or equivalent.

B. No attempt has been made to show all required piping supports in all locations, either on the drawings or in the details. The absence of pipe supports and details on any drawing shall not relieve the Contractor of the responsibility for furnishing and installing proper hangers and supports throughout.

C. Piping hangers shall be spaced on the scheduled maximum spacing and shall have hangers not more than one foot from each elbow and other changes in direction or elevation. Provide additional hangers and supports at valves, strainers, in-line pumps adjacent to flexible connections, and other required heavy components. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and miscellaneous steel supports as may be required to distribute the piping system load over multiple structural members where required or directed. Maximum allowable spacing for steel and copper piping, other than fire protection piping, shall be as scheduled in Table No. 1.

TABLE NO. 1

MAXIMUM SUPPORT SPACING FOR STEEL
AND COPPER PIPING SYSTEMS

Steel Piping	- Maximum Spacing
1/2"	- 5'-0"
3/4" and 1"	- 6'-0"
1-1/4" through 2"	- 8'-0"
2-1/2" through 6"	- 10'-0"
8" through 12"	- 12'-0"

Copper Piping	- Maximum Spacing
1/2"	- 5'-0
3/4" through 2"	- 6'-0"
2-1/2" through 4"	- 8'-0"
5" and larger	- 10'-0"

D. Round rods supporting the pipe hangers shall be of the minimum dimensions as scheduled in Table No. 2. Hanger rods shall be hot-rolled steel, ASTM A-36 or A575, galvanized, all-thread. Provide for controlling level and slope by turnbuckles or other approved means of adjustment and incorporate locknuts.

TABLE NO. 2

HANGER ROD SIZE FOR PIPE HANGER SUPPORTS

1/2" to 2" pipe	- 3/8" rod
2-1/2" to 3" pipe	- 1/2" rod
4" to 5" pipe	- 5/8" rod
6" pipe	- 3/4" rod
8" to 12" pipe	- 7/8" rod
14" and 16" pipe	- 1" rod
18" and 20" pipe	- 1-1/4" rod
24" and 30" pipe	- 1-1/2" rod

E. Cast iron soil, waste and vent piping shall be provided with steel clevis type hangers. Grinnell Fig. 590 at each pipe joint and at each fitting.

F. Hanger spacing for plastic piping system support shall be as scheduled below in Table No. 3 for PVC and CPVC and Table No. 4 for PVDF piping, based on pipe full of liquid with specific gravity of 1.0. See Table No. 5 for specific gravity correction factors. Piping may be continuously supported with a "V" or "U" shaped support made of metal or heat resistant approved plastic material. Hanger supports shall be in accordance with piping system manufacturer's recommendations.

TABLE NO. 3A
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS

SCHEDULE 40 PVC - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

	PVC AND CPVC				CPVC			
Size	60 & less	80	100	120	140	160	180	200
1/2" and 3/4"	5.5	5	4.5	4	3	3	3	2.5
1" and 1-1/4"	6	5.5	5.5	4.5	3.5	4	3.5	3
1-1/2" and 2"	6	6	5.5	4.5	3.5	4.5	4	3.5
2-1/2" and 3"	7.5	7	6.5	5.5	4.5	5.5	5	4
4"	8	7.5	7	6	4.5	6	5.5	4.5
5" and 6"	8.5	8	7.5	6.5	5	7	6	5
8"	9.5	9	8.5	7	5.5	7.5	6.5	5.5
10"	10	9	8.5	7	5.5	--	--	--
12"	10.5	10	9	8	6	--	--	--

TABLE NO. 3B
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS

SCHEDULE 80 PVC - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

	PVC AND CPVC				CPVC			
Size	60 & less	80	100	120	140	160	180	200
1/2"	6	6	5.5	4.5	3.5	3	2.5	2
3/4"	6.5	6	5.5	5	3.5	3	2.5	2
1" and 1-1/4"	7	6.5	6	5	4	3.5	2	2.5
1-1/2" and 2"	7.5	7	6.5	5.5	4	4	3.5	3
2-1/2" and 3"	8.5	8	7.5	6.5	5	4.5	4	3
4"	9.5	9	8.5	7	5.5	5.5	5	3.5
5" and 6"	10	9	8.5	7	5.5	6	5.5	4
8"	11.5	11	10	8.5	6.5	6.5	6	4.5
10"	12.5	12	11	9.5	7	--	--	--
12"	13.5	13	12	10	8	--	--	--

TABLE NO. 4
MAXIMUM SUPPORT SPACING FOR PVDF PIPING SYSTEMS

SCHEDULE 80 PVDF - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

Size	70 & less	100	140	180	200	250
1/2"	3	3	2.5	2.5	2	2
3/4"	3	3	3	3	2.5	2.5
1"	3.5	3	3	3	2.5	2.5
1-1/4"	4	3.5	3.5	3	3	3
1-1/2"	4.5	4	4	3.5	3.5	3
2"	5.5	5	4.5	4	3.5	3.5
2-1/2"	5.5	5	4.5	4.5	4	3.5
3"	5.5	5.5	5	4.5	4	4
4"	6	6	5.5	5	5	4.5

TABLE NO. 5
SPECIFIC GRAVITY CORRECTION FACTOR FOR PLASTIC PIPING SYSTEMS

Specific Gravity:	1.0	1.1	1.2	1.4	1.6	2.0	2.5
Correction Factor:	1.0	0.98	0.96	0.93	0.90	0.85	0.80

G. Fire protection system shall be supported in strict accordance with the requirements contained in the applicable NFPA pamphlets and as specified in Division 21, Fire Suppression Systems.

H. Hangers, clamps and other support materials in contact with copper piping shall be copper or copper plated to prevent electrolysis. Hangers for copper piping shall be copper plated adjustable ring type Grinnell Fig. CT-269, adjustable swivel ring, Grinnell Fig. CT69, Fig. CT-65 or adjustable clevis type or equivalent. Provide minimum 10 mil plastic wrap around copper pipe at any ferrous point of attachment including trapeze hangers, clamps, and other supports.

I. Hangers for steel shall be steel clevis type hangers, Grinnell Fig. 260 or equivalent.

J. Where piping is installed side by side, the Contractor may support the piping utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be galvanized steel channel, not less than 1-1/2" x 1-1/2" x 12" gauge, or Unistrut. Contractor shall provide heavier steel members as required for the load to be supported and the distance span. Trapeze hangers shall not be utilized fire and sprinkler piping and plumbing drain waste and vent piping. Hanger rods shall be as specified above, properly sized for the load supported but not less than 5/8" diameter. Un-insulated copper piping shall be isolated from the steel trapeze. Individual pipe shall be guided on the horizontal member at every other hanger point with 1/4" U-bolt fabricated from steel rod. Provide full circle galvanized sheetmetal insulation shield for insulated piping at trapeze hangers with U-bolt guide and galvanized sheetmetal insulation half-shield at other trapeze hangers. Insulation shield shall be 18 gauge minimum, Grinnell Fig. 167 or equivalent.

K. Vertical piping shall be supported at each floor level by means of riser clamps, Grinnell Fig. 261 and Fig. G-121, Erico, copper clad for copper piping systems, or equivalent. Proper allowance for the expansion and contraction of the vertical risers shall be provided. Contractor shall submit shop drawings indicating proposed method for support and control of expansion and contraction of vertical piping.

L. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.

M. All insulated piping systems specified in Section 22 0700, Plumbing Insulation and Section 23 0700, HVAC Insulation, shall be provided with individual hangers sized to encircle the insulation. Hangers for insulated domestic water piping and roof drain piping systems may be installed under the insulation. See applicable sections for insulation thickness requirements. The specified piping systems where supported by means of trapeze hangers shall not rest directly on the trapeze horizontal members. The insulation at hangers and trapeze hangers shall be protected by means of insulation shield, Grinnell Fig. 167, Erico, or equivalent. Grinnell Fig. 160, Erico, or equivalent, curved steel pipe saddle, shall be provided at roll hangers. Contractor shall provide section of high density calcium silicate insulation or thermal hanger shields as manufactured by Pipe Shields, Inc., or equivalent, at all insulation piping system hanger and support points for piping 1-1/2” or larger.

N. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Architect. The Contractor shall provide concrete inserts in the building construction at the time the concrete is poured and hangers shall be attached to these inserts. Self-drilling expansion anchors, Federal Specification FF-S-325, may be used in concrete construction not less than 4" thick. Applied load shall not exceed manufacturer's approved ratings. Power driven fasteners may be used in existing concrete or masonry not less than 4" thick where approved by the Architect. Attachment to steel construction shall be by means of beam clamps Grinnell Fig. 131, Erico, C-clamps Grinnell Fig. 86, Erico, or equivalent may be utilized for attachment of light loads as approved by the Structural Engineer. Attachment to wood construction shall be by means of wood screws or lag bolts.

2.6 PIPE SLEEVES

Pipe sleeves shall be furnished and set by the Contractor and he shall be responsible for their proper and permanent location. Piping will not be permitted to pass through footings, beams or ribs except with written consent of the Architect. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through gypboard stud walls and concrete, and masonry construction and at all fire and smoke rated walls and partitions. Pipe sleeves, except sleeves in footings and beams shall be equal to Pipe Shields Incorporated Model WFB for walls, DFB for decks, or QDFB for corrugated decks, or equivalent. Each sleeve shall be adjustable, with annular spacing packed with U.L. approved mineral fiber fire safing material. Where insulated piping is installed, calcium silicate inserts to match the insulation thickness and extending 1" past the sleeve on both ends, shall be provided. Pipe sleeves in concrete and masonry construction, footings and beams shall be Schedule 40 black steel pipe. Pipe sleeves in gypboard construction shall be galvanized steel metal. Sleeves shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed. Pipe sleeves in floors shall extend 2" above finished floor in chases and equipment room areas unless otherwise approved by the Architect. Openings between piping and sleeves shall be made watertight with plastic cement installed to a minimum depth of 2". Where pipes pass through exterior walls, the annular space between the wall and the pipe shall be sealed by sealing elements made of synthetic rubber, pressure plates, and cadmium plated bolts as manufactured by Link-Seal, or equivalent.

A. Un-insulated piping passing through fire walls, smoke wall, sound control walls and air plenum separations shall be sealed airtight to the adjacent construction by means of UL approved fireproof caulking materials.

B. Insulated piping passing through fire walls and smoke walls shall be provided with a section of UL approved fire safing insulation to match the required insulation thickness or Pipe Shields, Inc. pipe shield sleeves as specified above at the required wall penetrations. The space between the piping sleeve penetration and the adjacent wall Construction shall be sealed airtight with UL approved fireproof caulking material. Penetrations of gypboard sound walls and air plenum separators shall be caulked airtight with an approved caulking compound.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Provide and erect, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All piping shall be so installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining.

3.2 JOINTS

A. Caulked Joints: Caulked joints in hub-and-spigot piping and vent piping shall be packed firmly with white oakum, "Sealite No. 110," or hemp and caulked with pure molten lead not less than 1" deep. Resilient molded gasket joints or "Ty-Seal" may be used in lieu of lead and oakum for sanitary soil, waste and vent piping. No-hub pipe and fittings will be accepted with the exception that no-hub pipe and fittings shall not be allowed for buried installation.

B. Screwed Joints: Shall have American Taper pipe threads. Ream pipe ends and remove burrs after threading. Make up joints using Teflon tape or other approved compound applied to the male threads only.

C. Solder Joints: Copper tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a non-corrosive paste flux and solid 95-5 tin-antimony wire solder, unless otherwise specified. Cored solder will not be permitted. 50/50 lead solder shall not be permitted for any applications.

D. Welded Joints: On black steel piping 2-1/2" and above in size, the joints may be welded. Welding shall be done using either gas or electric welding equipment. Certified welders shall be used. Welders shall be certified in accordance with Section IX of ASME Boiler and Pressure Vessel Code, latest edition. All pipe surfaces shall be thoroughly cleaned before welding. Each joint shall be beveled before being welded. Piping shall be securely aligned and spaced, and the width of circumferential welds shall form a gradual increase in thickness from the outside surface to the center of the weld. All fittings used in the welded piping systems shall be standard ASA fittings, and shall be of standard pipe thickness. The Contractor shall provide a fireproof mat or blanket to protect the structure and adequate fire protection at all locations where welding is done. The use of fittings formed from welded pipe sections will not be permitted.

E. Flanged Joints: Flanged joints shall conform to the American Standard for cast iron flanged pipe fittings, Class 125, 150 or 300 as specified in the applicable Sections of these specifications. Gaskets shall be full face or ring type, non-asbestos, suitable for the service on which used.

3.3 EXPANSION AND CONTRACTION

A. The Contractor shall make all necessary provisions for expansion and contraction of piping with offsets or loops and anchors as required to prevent undue strain. Contractor shall provide shop drawings for proposed method and arrangement for control of expansion and contraction of piping. See Section 23 0505 for expansion joints, expansion compensators, pipe guides and pipe anchors.

3.4 PROTECTIVE COATINGS

A. All underground steel pipe shall be wrapped with "Scotchwrap" No. 50 tape or equivalent, to give not less than two complete layers on the entire underground piping system, or piping shall have X-Tru-Coat factory applied plastic protective covering.

3.5 FLUSHING, DRAINING AND CLEANING PIPE SYSTEMS

A. The Contractor shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

3.6 TESTING

A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than 150% of the maximum service pressure which the piping systems will be required to handle. Piping system tests shall be as specified in the applicable sections of this Specification. All tests shall be witnessed and approved by the Architect.

B. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests. To perform tests, all lines shall be flushed and cleaned.

C. All safety measures required by codes or ordinances or reasonably applicable to the situation shall be provided by the Contractor in conjunction with the testing of the piping systems.

D. Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Underground piping may be partially backfilled prior to pressure test when required for application of the test except that joints shall remain exposed until after the test. Tie rods, clamps etc., shall be in place and fastened.

E. Tests shall not be used to establish pressure ratings.

F. Protect all piping and equipment against over pressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.

G. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60^0F. Note that some applicable codes may require testing above a specified minimum temperature.

H. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test. Also remove all items such as orifice plates which might trap air in a system to be hydrostatically tested. Disconnect all instruments and air lines where copper tubing starts.

I. Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

J. During hydrostatic testing of lines, provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

END OF SECTION 230504

SECTION 230505 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0523, Valves.

1.3 SUBMITTAL DATA

A. Furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approval of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. 2.5-inch glycerin filled, SS case, 1.5% accuracy, dual scale (PSI & KPA), bronze bourdon tube and 0.25-inch NPT connection, brass snubber with properly selected filter disc for the application, and needle valve with knurled brass or ABS plastic handle. Provide multiple needle valves where a single pressure gauge is used to measure pressure at multiple points. Provide siphon for steam gauges. Winters, Weiss, Marshalltown, Ashcroft, Trerice, Weksler, or equivalent.

B. Select pressure range as indicated on the drawings, or if not indicated select so that the normal operating pressure is approximately 50% of the scale range. Provide compound and vacuum gauges where required by the application.

C. Install gauges so they are easily readable from normal operator level. Where the sensing location is not convenient to the operator, install the gauge and needle valves at a location easily read from normal operator level, extend piping from there to the sensing point on the main pipe, and provide a ball valve for isolation at the main. In addition, provide drain and vent valves to facilitate removing air and water from the sensing line.

2.2 THERMOMETER AND THERMOMETER WELLS

A. Either liquid filled or digital type, vari-angle, 3-1/2" stem for pipe sizes through 6" and 6" stem for pipe sizes 8" and larger, dual scale (degrees F & C), separable brass socket, extension neck where installed in insulated piping, and accuracy 1% of range. Winters, Weiss, Moeller, Trerice, Weksler, Duro, or equivalent.

1. Liquid Filled Type: 9" case, straight form, V-shaped, high pressure die cast aluminum, baked enamel finish, with heavy glass-protected front firmly secured with spring action, and organic liquid filled magnifying lens. Winters 9IT or approved equal.
2. Digital Type: May be used both indoors or in outdoor locations not exposed to sunlight, high impact ABS plastic housing, suitable for operation at 16 Lux. Winters 9IT or approved equal.

B. Ranges: Provide the following ranges except where otherwise indicated:

Domestic Hot Water	30-180 degrees F

2.3 MANUAL AIR VENTS

A. Provide manual air vents at locations indicated on the drawings, at the high point of all liquid piping system and as otherwise required for proper air elimination and liquid circulation.

B. Manual air vents shall be 1/2" brass ball valves as specified in Section 23 0523. Provide brass hose connection and plug on valve outlet.

2.4 AUTOMATIC AIR VENT

A. Provide automatic air vents for all separators, at the high point of all hydronic systems and at locations indicated on the drawings. Automatic air vents shall be 3/4" size, minimum. Provide manual shut-off ball valve between automatic air vent and piping system. Automatic air vents shall be float type, 150 PSIG maximum working pressure, 3/4" NPT system connection, Amtrol Model No. 720, Taco, Armstrong, Watson-McDaniel, Hofmann, or equivalent.

2.5 MANUAL DRAIN VALVES

A. Provide manual drain valves at locations indicated on the drawings, at the low points of all liquid piping systems, and as otherwise required for proper draining of systems. Manual drain valves shall be sized as shown on the drawings but not less than 3/4" size, brass ball valve, as specified in Section 23 0523. Pipe discharge from drain valves to floor drain, floor sink, or as otherwise directed for indirect discharge into sanitary sewer system. For drain valves located above ceiling or in location outside mechanical equipment areas provide brass hose connection and cap for valve discharge.

2.6 TEMPERATURE AND PRESSURE TEST PLUGS

A. 0.25 or 0.5-inch NPT with brass body, EPDM core, and brass gasketed cap. Winters, Peterson, or approved equal. Supply one pressure/temperature test kit with two 4" Duro #105 pressure gauges of 1% accuracy and ranges as required by application; and two 2" Tel-Tru #39R Bi-metal thermometers with 8" stem, 1% accuracy, and ranges as required by the applications; and a protective carrying case.

2.7 FLEXIBLE CONNECTORS

A. Furnish and install flexible connectors at locations indicated on the drawings and at all piping connections associated with equipment mounted on or hung from vibration isolators. Flexible connectors shall be constructed of multiple ply nylon cord fabric and neoprene, operating pressure 150 PSIG at 220^{O}F through 12" size and operating pressure of 125 PSIG at 220^{O}F for sizes 14" through 24". Provide butyl or Hypolon liner and applications with fluid temperatures in excess of 225^{O}F.

B. Flexible connectors shall be single or twin sphere with Class 150 flange connections for sizes 2-1/2" and larger and threaded connections with galvanized female unions for sizes 3/4" through 2". Mason Industries MFTCR, Hyspan, Metra-Flex, Keflex, Proco, or equivalent. Flexible connectors required for outdoor installation shall be braided brass type.

C. Installation of flexible connectors shall be in strict accordance with manufacturer's recommendations. Spacing between piping system flanges shall be based on the flexible connector's expanded length corresponding to the system's operating pressure. Control rods or cables shall be provided for units installed in unanchored applications where system operating pressure and dynamic forces exceeds manufacturer's recommendations for unrestrained installations.

2.8 EXPANSION JOINTS

A. Furnish and install corrugated bellows expansion joint, Hyspan Series 1500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, self-equalizing, 150 PSIG working pressure at 850^{o}F, Class 150 ASA flange connections 1-1/2" size and above, single or dual center base configuration as shown on the drawings, constructed of corrugated Type 304 or 321 stainless steel, ring controlled, with integral stainless steel or Monel sleeve, and removable carbon steel external housing to protect bellows and support insulation. Furnish limit rods to prevent expansion joint from exceeding rated travel. Joint design shall be for maximum flexibility over 10,000 cycles minimum.

B. Expansion joint sizing and installation shall be as shown on the drawing and as recommended by the manufacturer.

C. Expansion joints shall be insulated with flexible 2" minimum thickness of high temperature fiberglass blanket insulation furnished with joint and installed under the external protective housing.

D. Contractor shall carefully check expansion joint limit rods and make adjustments as required to ensure proper joint movement and operation.

2.9 PIPE ALIGNMENT GUIDES

A. Furnish and install factory fabricated steel pipe alignment guides, Hyspan Series 9500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, to maintain the longitudinal position of pipe centerline between expansion joints and compensators with axial restraint. Alignment guides shall consist of a bolted two-section outer cylinder and base with two-section guiding spider bolted tight to the pipe guide. Guide and spider shall be sized to clear pipe and pipe insulation and long enough to prevent over travel of spider and cylinder. Guides shall not be used for pipe support.

B. Alignment guides shall be arranged and installed as shown on the drawings and as recommended by the manufacturer.

2.10 PIPE ANCHORS

A. Pipe anchors shall be constructed of welded steel as detailed on the drawings.

B. Pipe anchors shall be arranged as shown on the drawings and as required to properly control/piping system expansion and contraction in conjunction with system flexibility due to off-sets, bends, and loops and expansion joints and compensators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All specialties shall be installed in accordance with the best standard practices and as recommended by the manufacturer.

B. Install thermometers so they are easily readable from operator level.

C. Where thermometers, gauges, vents and test fittings occur in insulated piping systems or on insulated equipment, extension necks shall be provided to extend beyond the insulation.

3.2 AIR VENTS

A. Manual air vents shall be installed as specified herein and at the high points in all piping systems.

B. Automatic air vents shall be installed as specified herein and at locations indicated on the drawings. Automatic air vents shall be installed level and in accordance with manufacturer's directions to properly vent system, complete with individual isolation valves.

3.3 TEST AND ADJUSTMENT

A. Field adjust all water pressure regulating valves, flow switches, water level controls, and specialties to provide required system operation.

B. Field test and verify the operation of all safety devices including water relief valves and temperature and pressure relief valves.

3.4 RELIEF VALVE DISCHARGE

A. Water pressure relief valve and water temperature and pressure relief valve discharges shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink, and as allowed by the Building Mechanical and Plumbing Codes. When the operating discharge temperature is in excess of 212^{o}F, the discharge shall be equipped with a splash shield or centrifugal separator.

B. Water reduced pressure backflow preventer discharge shall be piped full size to the outside of the building or discharged indirectly into a properly sized building floor drain or floor sink as allowed by the Building Mechanical and Plumbing Codes. Provide a bronze air gap funnel with stainless steel fasteners for installation under reduced pressure backflow prevention relief valve. Febco Model AGD or equivalent, 1" discharge pipe size for backflow preventer size through 2".

END OF SECTION 230505

SECTION 230523 - VALVES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: Valves shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0523 for Valve Identification.

C. Section 23 0504 for Pipe and Pipe Fittings.

D. Division 21 for fire suppression system valves and tamper switches.

E. Division 22 for plumbing system.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Tyco-Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Tyco-Grinnell, Victaulic, Nibco, or Dezurik,, or equivalent. Butterfly valves may be used for closed circuit chilled water, heating hot water (200°F maximum) run-around coil and heat pump circulating water systems and for condensing water systems. Butterfly valves shall not be used for domestic water or other non-specified service.

D. Ball valves shall be utilized in lieu of gate valves and globe valves for all HVAC and plumbing systems for sizes 2" and smaller.

E. Butterfly valves may be substituted for gate, globe and ball valves for specified services, and for other services as may be approved by the Architect.

F. All valves furnished under Division 22 and 23, of the same type, shall be products of a single manufacturer unless otherwise approved by Owner's Representative.

G. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

H. Provide chain operators for valves 4" and larger installed within mechanical equipment spaces where valves center line is in excess of eight feet above the floor or operating platform and as otherwise indicated on the drawings.

PART 2 - PRODUCTS

2.1 GENERAL SERVICE VALVES, HVAC AND PLUMBING SYSTEMS

A. Gate Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, solid disc, rising stem, gland packed, non-asbestos packing. Milwaukee 148 (Threaded) or equivalent; Milwaukee 149 (Solder), or equivalent.

B. Gate Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1151 (Threaded) or equivalent; Milwaukee 1169 (Solder), or equivalent

C. Gate Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1184 (Threaded) or equivalent.

D. Gate Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 125 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2885 or equivalent.

E. Gate Valves - 2-1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 250 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2894 or equivalent.

F. Globe Valves - 2" and Smaller, Class 125: Valves 2-1/2" and smaller shall be of ASTM B-62, Class 125 construction, bronze trim, gland packed, non-asbestos packing. Milwaukee 502 (Threaded), or equivalent; Milwaukee 1502 (Solder) or equivalent.

G. Globe Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be of ASTM B-62, bronze, Class 150 construction, bronze trim, composition disc, union bonnet, gland packed, non-asbestos packing. Milwaukee 590 (Threaded) or equivalent; Milwaukee 1590 (Solder), or equivalent.

H. Globe Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be of ASTM B-62, bronze, Class 300 construction, bronze trim, union bonnet, gland packed, non-asbestos packing. Milwaukee 572 (Threaded) or equivalent

I. Globe Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and Larger shall be of ASTM A-126, Class B cast iron, flanged ends, Class 125 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2981M or equivalent.

J. Globe Valves - 2-1/2" and Larger, Class 300: Valves 2-1/2" and larger shall be of ASTM A-126, Class B cast iron, flanged ends, Class 300 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2983 or equivalent.

K. Check Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, Y-pattern, swing type design, teflon seat, disc for steam service, Buna-N for water service. Milwaukee 509 (Threaded) or equivalent; Milwaukee 1509 (Solder) or equivalent.

L. Check Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, Y-pattern, swing type design, bronze seat, composition disc, teflon seat disc for steam service, Buna-N for water service. Milwaukee 510 (Threaded) or equivalent; Milwaukee 1510 (Solder) or equivalent.

M. Check Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, Y-pattern, swing type design, bronze regrinding disc. Milwaukee 507 (Threaded) or equivalent.

N. Check Valves - 2 1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2974M or equivalent.

O. Check Valves - 2 1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 250 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2970 or equivalent.

2.2 BUTTERFLY VALVES

A. Valves 2-1/2" and larger shall be full lug pattern, ASTM A-216, Class B cast iron body, 416-SS stems, aluminum/bronze disc, EPDM liner and seats (-30°F to 275°F) w/rigid phenolic cartridge, 200 PSIG working pressure with Bubble tight shut-off. Valves shall be for mounting

between flanges with lugs drilled and tapped so that pipe may be disconnected on either side of valve with opposite end remaining under pressure. Milwaukee ML-123-E or equivalent.

B. Valves 4" and smaller shall be provided with level handler operator with spring loaded lock stops. Valves 5" and larger shall be furnished with manual gear operator with hand wheel.

C. Valves installed for insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing.

D. Butterfly valves furnished for use in grooved piping system shall meet the material specification requirements as specified herein.

2.3 BALL VALVES

A. Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, 600 PSI W.O.G. Two-piece body, chrome plated ball, blowout proof stem, reinforced TFE seats, non-asbestos packing. Milwaukee BA-100 (threaded) or equivalent. Milwaukee BA-150 (solder) or equivalent.

B. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing. Cutting or notching of the insulation or bending of handles shall not be permitted.

2.4 BALANCE VALVES

A. Valves 2" and smaller: Ball valve, bronze, Class 150 construction, 600 PSI W.O.G., Two piece body, Milwaukee BA-100 (threaded). Milwaukee BA-150 (soldered), as specified herein or equivalent.

B. Valves 2-1/2" and larger: Lubricated plug valve, cast iron construction, 175 PSI W.O.G., Class 125 flange connections, level handle for valves 4" and smaller, manual gear operator with handle wheel for valve 5" and larger. Walworth No. 1797F or equivalent.

C. Valves 2-1/2" and larger:

1. Butterfly valve, full lug pattern, as specified herein.
2. Furnish level handle with infinite throttling positions and locking device for securing handle in any position for valves 4" and smaller and manual gear operator with hand wheel for valves 5" and larger.

2.5 NATURAL GAS VALVES

A. Valves 3/4" and Smaller: Bronze natural gas cock, Walworth No. 590 (square head), Walworth 591 (flat head) or equivalent.

B. Valves 3" and Smaller: Ball valve shall be cast of ASTM B-584 bronze, Class 250 construction, threaded connections, chrome plated big ball and stem, RDTFE seat and stem packing, blow-out proof stem, UL Listed for natural gas service, Apollo 80-100 Series or equivalent.

C. Valves 4" and Larger: Lubricated plug valve, cast iron construction, 175 PSIG W.O.G., threaded connection for valves 2" and smaller, Class 125 Flange connections, level handle operator. Walworth No. 1797F (Flanged) or equivalent.

2.6 MANUAL AIR VENTS AND DRAIN VALVES

A. For manual air vents and drain valves, see Specification Section 23 0505, Piping Specialties.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.

B. Gate and Globe valves shall be installed with stems horizontal.

END OF SECTION 230523

SECTION 230549 - HVAC AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0900, Automatic Temperature Controls.

C. Division 26 for Electrical.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 23 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 23	Div. 23	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div. 23
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 23
Variable Frequency Drives (VFD's)		Div. 23	Div. 23	Div. 26	Div. 23
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 23	Div. 23	Div. 26	Div. 23
Refrigeration Gas Monitor		Div. 23	Div. 23	Div. 26	Div. 23
Kitchen Make-up System & Hood Exhaust Fans		Div. 23	Div. 23	Div. 26	Div. 26
Kitchen Exhaust Hoods & Lab Fume Hoods		Div. 11	Div. 11	Div. 26	N/A
Kitchen Hood Fire Protection System		Div. 11	Div. 11	Div. 26	N/A
Kitchen Hood Natural Gas Shut-Off Valve		Div. 11	Div. 23	Div. 26	N/A
Fan Coil Units Including		Div. 23	Div. 23	Div. 26	Div. 23
Min. Outside Air Units Including Mixing Dampers		Div. 23	Div. 23	Div. 26	Div. 23
Rooftop A/C Units Including Mixing Dampers		Div. 23	Div. 23	Div. 26	Div. 23
HVAC Unit Smoke Detectors		Div. 28	Div. 23	Div. 26 / 28	Div. 28
Fire/Smoke Control Dampers & Smoke Dampers		Div. 23	Div. 23	Div. 26	Div. 28
Fan Coil Unit Condensate Float Switches		Div. 23	Div. 23	N/A	Div. 23
Supply, Return & Exhaust Fan with unit mounted 115 VAC 2-position damper actuators interlock with fan motor/starter		Div. 23	Div. 23	Div. 26	N/A
Non-FMS Control Devices Including Wall Switches, Timers, Thermostats		Div. 23	Div. 23	Div. 26	Div. 26
Fire Alarm System & Interface w/HVAC System		Div. 28	Div. 28	Div. 28	N/A

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall provide 120 VAC power to each mechanical space and the central plant as indicated on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 23 indicates the HVAC contractor or their designated representative including equipment suppliers, sub-contractors, etc.

END OF SECTION 230549

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Testing and balancing of the mechanical systems shall be under the direction and coordination of the HVAC and Controls Performance Assurance Contractor (PAC) directly contracted by the Owner. THE PAC SHALL PROVIDE THE OWNER'S TEST AND BALANCE (TAB) SERVICES and shall be responsible for coordination, supervision, execution, furnishing the data required by the test procedures, and report preparation for the testing, adjusting, and balancing requirements outlined in this Section.

B. TAB will be provided by the Owner's PAC and paid for by the Owner. This Section serves to clarify the responsibilities of the Contractor and describes the procedures of the Owner's PAC.

C. During the testing, adjusting, and balancing work, the Owner's PAC may identify issues or recommended corrective measures. These will be compiled in the Installation Issues Log maintained by the PAC and RFIs will be created by the PAC as appropriate. The Construction Stage Deficiency Log will be promulgated to responsible parties via the Owner's Representative and the Architect. *IMPLEMENTATION OF CORRECTIONS SHALL BE PERFORMED BY THE CONTRACTOR AT NO ADDITIONAL CHARGE*. If the Contractor believes recommended corrections are beyond the scope of work specified in the contract, it shall be the Contractor's responsibility to request and receive written change order authorization through the Owner's established process prior to undertaking those recommended corrections.

D. The Contractor shall provide services of a qualified manufacturer's representative of the Direct Digital Control System and qualified representatives of the mechanical and electrical subcontractors as required for the TAB work and *CONTRACTOR SHALL INCLUDE CONTRACTOR'S COST FOR THE CONTRACTOR'S TESTING, ADJUSTING, AND BALANCING REQUIREMENTS IN HIS CONTRACT PRICE. SERVICES OF THE TAB AGENCY SHALL BE PROVIDED BY THE OWNER AND ARE NOT PART OF THE CONTRACT PRICE*.

E. Mechanical system installation, start-up, initial testing, the preparation of Operation and Maintenance Manuals, and operator training are the responsibility of the Contractor. The testing, adjusting, and balancing requirements in this Section do not relieve the Contractor from the obligations to complete all portions of the work in a satisfactory and fully operational manner.

F. The Owner's PAC shall include the following in its Scope of Work:

1. Perform Testing and Balancing of the systems. Contractor shall provide full-time services of electrical and control subcontractors for this testing and balancing work.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. The general provisions of the Contract, including General Conditions, Supplementary General Conditions (if any), and General Requirements apply to the work specified in this Section.

B. Section 23 0500 Common Work Requirements for HVAC

C. Section 23 0523 Valves

D. Section 23 0549 HVAC & Elec Installation Coordination

E. Section 23 0810 Performance Assurance for HVAC

F. Section 23 0900 Automatic Temperature Controls

G. Section 23 3000 Air Tempering System Equipment

H. Section 23 7413 Packaged Outdoor Central Station AHU

1.3 REFERENCES

A. AABC – National Standards for Total System Balance

B. ASHRAE 111 – Practices for Measurement, Testing, Adjusting, and Balancing of Environmental Systems

C. NEBB – Procedural Standards for Measurement, Testing, Adjusting, and Balancing of Environmental Systems

D. SMACNA – HVAC Systems Testing, Adjusting, and Balancing

1.4 SUBMITTALS BY OWNER'S PAC

A. Field Reports indicating deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

B. Report forms or outlines indicating adjusting, balancing, and equipment data required. Submit prior to commencing work.

C. Test Reports including data on forms containing information indicated in Schedules.

D. Draft copies of TAB Report for review prior to Substantial Completion of Project.

E. Copies of final TAB Report for inclusion in the Final HVAC and Controls Performance Assurance Report

F. Provide submittals and reports to PAC for transmittal to Owner's Representative and Design Professional.

G. Provide reports in letter size, 3-ring binder manual format complete with index page, indexing tabs, and with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat/temperature sensor locations.

1.5 QUALITY ASSURANCE

A. Perform total system balance in accordance with NEBB Procedural Standards.

1.6 SEQUENCING

A. Sequence TAB work in conjunction with work by the Contractor. TAB work and milestones shall be incorporated in the Contractor's Project Schedule.

B. Sequence TAB work to commence after completion of systems. TAB work shall be completed as a prerequisite for Substantial Completion of the Project.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 AGENCIES

A. The independent Owner's PAC will be responsible for coordination, supervision, execution, and report preparation for the testing, adjusting, and balancing requirements of this Section.

3.2 SYSTEM READINESS

A. Contractor shall verify that systems are installed, complete and operable before the commencement of TAB work. The contractor shall insure the following conditions: Systems are started and operating in a safe and normal condition.

1. Automatic temperature controls are installed complete and operable including verification of proper end device operation and installation of required occupancy schedule programming.
2. Proper thermal overload protection is in place for electrical equipment
3. Final filters are new and in place.
4. Coil fins are clean and combed if needed
5. Duct systems are clean of debris.
6. Fans are rotating correctly
7. Motors and bearings are properly lubricated.
8. Any excessive vibration has been corrected.
9. Fire/Smoke and volume dampers are in place, open, and operating properly.
10. All ductwork connections are complete, access doors are closed, and duct end caps are in place.
11. Air outlets are installed and connected.
12. Duct system leakage is minimized per the Specifications.
13. Water systems have been flushed, refilled, and vented.
14. Strainers or filters are in place and clean.
15. Control valves, check valves, and flow meters are installed and operating properly.
16. All manual valves, balancing devices, and control valves are open.
17. Pump rotation is correct and water is flowing.
18. System make-up water pressure is properly adjusted.

B. Construction Checklist forms to verify the readiness of systems for TAB work are provided following the end of this Section. The project-specific Construction Checklists developed by the Owner's PAC shall be used for the project. The Contractor shall have personnel with direct knowledge complete the individual checklists to verify that systems are installed, complete and operable prior to the commencement of TAB work. *These checklists do not replace any manufacturer-recommended procedures*.

C. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed Construction Checklists forms for mechanical inspection of the project. This inspection shall be conducted by a duly appointed representative of the Mechanical Engineer's office, the Mechanical Contractor's Superintendent, and representatives of the Owner's PAC. The inspection shall establish to the satisfaction of all parties that the systems are ready for testing and balancing.

D. If the Owner's PAC finds that systems are not ready for TAB services Contractor will be subject to charges for the Owner's PAC's lost time and expenses.

3.3 PREPARATION

A. The Owner's PAC shall provide necessary calibrated instruments required for testing, adjusting, and balancing operations. The Owner's PAC shall make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Additional balancing devices, if required, shall be furnished and installed by Contractor.

3.4 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design conditions for supply systems and within plus or minus 10 percent of design conditions for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus or minus 10 percent of design conditions to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design conditions.

C. If tested air quantities are not within the required limits, the Contractor must replace fan pulleys, sheaves, belts, or add balancing dampers, etc. as required to meet the Specifications. If acceptable to Contractor, TAB Agency may install replacement pulleys, sheaves, or belts as required to meet the Specifications. Installation of pulleys, sheaves, or belts by TAB Agency shall have no effect on Contractor's warranty.

D. Water: Adjust to within plus or minus 10 percent of design conditions.

3.5 ADJUSTING BY OWNER'S PAC

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices to allow settings to be restored. Set and lock memory stops.

C. After adjustments, take measurement to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replace belt guards, close access doors, close doors to electrical switch boxes, restore thermostats to specified settings, and restore Direct Digital Control System to normal operation.

E. At Final Inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.6 PROCEDURE BY OWNER'S PAC

A. Air Handling and Distribution Systems

1. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
2. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
3. The total air volume handled by the system shall be determined by means of a Pitot tube and draft gauge. The total air delivered by each duct shall be measured by Pitot tube traverses.
4. The average velocity in the duct shall be determined by velocity readings which are taken in the center of equally divided areas in the cross section of the duct. The number of areas

in which velocity readings are to be taken is determined by the size of the duct, based on a maximum size of equally divided areas of 8 inches.

5. Measure air quantities at air inlets and outlets. The volume dampers, pressure controllers, outlets and other devices shall be adjusted so the air volumes will be as shown on the drawings.
6. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
7. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
8. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
9. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
10. Measure air static pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
11. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
12. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
13. Where modulating dampers are provided, take measurements and balance at extreme conditions.
14. Measure building static pressure and adjust supply, return, and exhaust systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
15. On completion of the test the Owner’s PAC shall prepare a typewritten report showing the tested values for inclusion in the Final HVAC and Controls Performance Assurance Report. This report shall include all flows, temperatures, temperature drops, and motors for the plumbing and mechanical systems. The CFM of each supply outlet with corresponding room number shall be included. This report shall include the fan RPM, nameplate data, the voltage and amperage readings of the fan motors, and the fan suction and discharge static pressure.

B. Water Systems

1. Verify systems have been flushed clean, strainers and filters are in place and clean, and that the system has been refilled and vented.
2. Verify that Contractor has installed all temperature and pressure test plugs as required to obtain a thorough flow test.
3. Provide air and water entering and leaving conditions on all equipment.
4. Record pump flow rates, pressures, running amperage, and full load amperage at design flow and shut off conditions.

3.7 SCHEDULES BY OWNER’S PAC

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. Air Handling Units
2. Fans
3. Air Filters
4. Air Inlets and Outlets
5. Automatic Temperature Controls – Thermostats and Timeclocks.

B. The Owner's PAC's report shall contain all test, adjustment, and balance data and information on any discrepancies from the specifications or design conditions. The following should be included as a minimum:

1. Title Page

    a. Name of Owner's PAC
    b. Address of Owner's PAC
    c. Telephone Number(s) of Owner's PAC
    d. Project Name
    e. Project Location
    f. Project Architect
    g. Project Engineer
    h. Project Contractor
    i. Project Altitude
    j. Report Data

2. Summary Comments

    a. Final Performance versus Design
    b. Notable characteristics of systems
    c. Identify any instances where the actual control sequence of operation varies from the designed and submitted sequences.
    d. Summary of outdoor and exhaust air flows to indicate amount of building pressurization
    e. Nomenclature used throughout report
    f. Test conditions

3. Instrument List

    a. Instrument Used
    b. Manufacturer
    c. Model Number
    d. Serial Number
    e. Calibration Date

4. Electric Motors

    a. Manufacturer
    b. Model/Frame
    c. HP/BHP
    d. Phase, voltage, amperage, nameplate, actual, no load
    e. RPM
    f. Service factor
    g. Starter size, rating, heater elements

h. Sheave make, size, bore (as installed and any replacement)

5. V-Belt Drive

a. Identification/Location
b. Required driven RPM
c. Driven sheave diameter and RPM (as installed and any replacement)
d. Belt size and quantity
e. Motor sheave diameter and RPM (as installed and any replacement)

6. Air Moving Equipment

a. Location
b. Manufacturer
c. Model Number
d. Serial Number
e. Supply air flow - specified and actual
f. Return air flow - specified and actual
g. Outside air flow - specified and actual
h. Total external static pressure – specified and actual
i. Inlet pressure
j. Discharge pressure
k. Sheave - make/size/bore (as installed and any replacement)
l. Belts - make/size/quantity
m. Fan RPM

7. Return Air/Outside Air Data

a. Identification/location
b. Design air flow
c. Actual air flow
d. Design return air flow
e. Actual return air flow
f. Design outside air flow
g. Actual outside air flow
h. Return air temperature
i. Outside air temperature

8. Exhaust Fan Data

a. Location
b. Manufacturer
c. Model Number
d. Serial Number
e. Air flow - specified and actual
f. Total external static pressure – specified and actual
g. Inlet pressure
h. Discharge pressure
i. Sheave - make/size/bore (as installed and any replacement)
j. Belts - make/size/quantity
k. Fan RPM

9. Duct Traverse

    a. System zone/branch
    b. Duct size
    c. Area
    d. Design velocity
    e. Design air flow
    f. Test velocity
    g. Test air flow
    h. Duct static pressure
    i. Air Temperature
    j. Air correction factor

10. Domestic Water Systems

    a. Location
    b. Pump Manufacturer
    c. Pump Model Number
    d. Pump Serial Number
    e. Water flow - specified and actual
    f. Total pressure – specified and actual
    g. Suction pressure
    h. Discharge pressure
    i. Full load amperage at design flow and shut off conditions

11. Vibration Test (by Owner's PAC if required by Owner)

    a. Location of points
        i. Fan/pump bearing drive end
        ii. Fan/pump bearing opposite end
        iii. Motor bearing drive end
        iv. Motor bearing center (if applicable)
        v. Motor bearing opposite end
        vi. Casing bottom or top
        vii. Casing side
        viii. Duct after flexible connection (discharge)
        ix. Duct after flexible connection (suction)

    b. Test readings
        i. Horizontal - velocity and displacement
        ii. Vertical - velocity and displacement
        iii. Axial - velocity and displacement

    c. Normally acceptable readings, velocity and acceleration
    d. Unusual conditions at time of test
    e. Vibration source if non-complying

12. Life Safety Systems

a. The Contractor shall be required to demonstrate satisfactory operation of Life Safety Controls and Smoke Damper operation to the Test and Balance Agency unless the appropriate Authority Having Jurisdiction requires separate verification by the local Fire Marshal.

Example Construction Checklist
Air Handling Unit

Project:		
Location:	System/Equipment:	
Manufacturer:	Model:	Serial:
Area/System Served:		

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. *This checklist does not replace any manufacturer recommended procedures.* Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish that the systems are ready for testing and balancing.

Pre-start Checks - Check box for completion	✓	N/A	Comment
Components, dampers, actuators, mounting, & isolation installed			
Plenums & ductwork connected and sealed			
Fire dampers installed, tested and under control			
Coil piping & valves installed, labeled and tested			
Balancing devices & test points installed as shown on drawings			
Isolation valves are open, air has been bled; water is flowing			
Condensate drains installed and clear			
Electrical connections completed properly			
Disconnect switch installed properly			
Starter is installed with proper heaters			
Temperature/pressure gauges and sensors properly located			
Fan/motor alignment performed; belts properly adjusted			
Equipment guards in place			
Fan and motor bearings lubricated and fan/motor turns freely			
Building controls/DDC system operational			
Filters are installed and are clean			
Uninterrupted electrical power is available from a permanent source			
Ready to start and operate under control			

Startup/Operational Checks Check box for completion	✓	N/A	Comment
Startup by Manufacturer's Representative			
Mechanical, Electrical, and Controls Contractors			

present			
Fan rotation is correct (bump)			
Operation of Electrical & Controls interlocks verified			
Fan status indicators verified			
Freeze protection is operational			
Dampers easily stroke to full positions and span is calibrated			
Local air leakage is acceptable			

Startup/Operational Checks (Continued) Check box for completion	✓	N/A	Comment
HOA switch operates in all positions; safeties operate when in Hand			
Motor Amps: Rated_____ Actual _____			
Motor Voltage: Rated_____ Actual _____			
Vibration/noise level is acceptable			
Equipment has run continuously for a minimum of (4) hours			
Preliminary O&M Manuals provided to Owner			

The above checklist items have been verified complete:

Contractor Name	Signature	Date

The above system/equipment has been verified ready for testing, adjusting and balancing:

Mechanical Engineer Name	Signature	Date

Example Construction Checklist
Direct Digital Control (DDC) System

Project:	
Location:	System/Equipment:
Manufacturer:	
Area/System Served:	

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. *This checklist does not replace any manufacturer recommended procedures.* Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish that the systems are ready for testing and balancing.

Pre-start Checks Check box for completion	✓	N/A	Comment
Controls submittals are complete			
Thermostats, sensors, dampers, actuators, and control valves properly installed			
Control wiring properly connected to each point; free of shorts and ground faults			
All terminations tight			
Shielded wire used on electronic sensors			
Controlled components properly labeled/tagged			
Layout & location of control panels matches drawings			
Control components properly wired to each labeled terminal strip			
Battery backups in place and operable			
Panels properly grounded			
Operator interface is installed with all required software			
All programming is installed properly			
System date/time is correct			
Uninterrupted electrical power is available from a permanent source			
Ready to start and operate under control			
Startup/Operational Checks Check box for completion	✓	N/A	Comment
Startup by Manufacturer's Representative			
Mechanical/Electrical/Controls Contractors present			
Calibration of each input device has been verified			
Proper operation of all binary & analog output devices verified			
Normal positions verified correct for all devices			
Valve stem/damper start, span, and travel adjusted			
Sensor readings in control system verified to be within specified accuracy			

Operational test of each control loop performed			
Systems operate according to specified sequences			

Startup/Operational Checks (Continued) Check box for completion	✓	N/A	Comment
PID and control loops are tuned			
Operation of all operator interfaces verified			
Web browser communication verified			
Alarms and interlocks have been tested			
Fire alarm system interface verified			
Graphical trend data showing DDC loop response to setpoint change provided per specification			
Trend data documenting demand-limiting algorithm provided per specification			
Trend logs including setpoints, operating points, valve positions, etc. provided per specification			
Written copy of all control parameters and setpoints, and Descriptive Points List is on site			
As-built control drawings on site			
Point-to-point checkout documentation on site			
System has run continuously; minimum of (4) hours			
Preliminary O&M Manuals provided to Owner			

The above checklist items have been verified complete:

Contractor Name	Signature	Date

The above system/equipment has been verified ready for testing, adjusting and balancing:

Mechanical Engineer Name	Signature	Date

Example Construction Checklist
Ductwork

Project:
Location:
Area/System Served:

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish to the satisfaction of all parties that the systems are ready for testing and balancing.

Pre-start Checks Check box for completion	✓	N/A	Comment
Installation complete			
Ductwork is clean and free of debris			
Balancing dampers are installed, operable and open			
Control dampers properly installed and accessible			
Fire, smoke, and combination dampers properly installed, open and under control			
Access doors installed per specifications			
Ductwork is sealed per specifications			
Testing has been performed where required			
Duct insulation is properly installed			
Flex duct run lengths do not exceed specifications			
Registers, grilles and diffusers are installed and open			
Startup/Operational Checks Check box for completion	✓	N/A	Comment
Control dampers easily stroke to full positions and span is calibrated			
Local air leakage is acceptable			
Air noise level is acceptable			

The above checklist items have been verified complete:

Contractor Name	Signature	Date

The above system/equipment has been verified ready for testing, adjusting and balancing:

Mechanical Engineer Name	Signature	Date

Example Construction Checklist
Exhaust Fans

Project:		
Location:	System/Equipment:	
Manufacturer:	Model:	Serial:
Area/System Served:		

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. *This checklist does not replace any manufacturer recommended procedures.* Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish that the systems are ready for testing and balancing.

Pre-start Checks Check box for completion	✓	N/A	Comment
Components, dampers, actuators, filters, mounting, & isolation installed			
Plenums & ductwork connected and sealed			
Fire dampers installed, tested, and under control			
Backdraft dampers free to operate			
Balancing dampers installed and locked open			
Electrical connections completed properly			
Disconnect switch installed properly			
Starter is installed with proper heaters			
Fan/motor alignment performed; belts properly adjusted			
Equipment guards in place			
Fan and motor bearings lubricated and fan/motor turns freely			
Building controls/DDC system operational			
Uninterrupted electrical power is available from a permanent source			
Ready to start and operate under control			

Startup/Operational Checks Check box for completion	✓	N/A	Comment
Mechanical, Electrical, and Controls Contractors present			
Fan rotation is correct (bump)			
Operation of Electrical & Controls interlocks verified			
Fan status indicators verified			
Dampers easily stroke to full positions and span is calibrated			
Local air leakage is acceptable			
HOA switch operates in all positions; safeties operate when in Hand			

Startup/Operational Checks (Continued) Check box for completion	✓	N/A	Comment
Vibration/noise level is acceptable			
Equipment has run continuously for a minimum of (4) hours			
Preliminary O&M Manuals provided to Owner			

The above checklist items have been verified complete:

Contractor Name	Signature	Date

The above system/equipment has been verified ready for testing, adjusting and balancing:

Mechanical Engineer Name	Signature	Date

Example Construction Checklist
Packaged Gas-Fired Heat/Cool HVAC Units

Project:		
Location:	System/Equipment:	
Manufacturer:	Model:	Serial:
Area/System Served:		

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. *This checklist does not replace any manufacturer recommended procedures.* Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish that the systems are ready for testing and balancing.

Pre-start Checks Check box for completion	✓	N/A	Comment
Mounting, isolators, etc. installed properly			
Gas piping, burner, and gas train installed & tested			
Gas pressure at burner is as specified			
Venting and combustion air installed properly			
Plenums & ductwork connected and sealed			
Fire dampers installed, tested, and under control			
Fan/motor alignment performed; belts properly adjusted; bearings lubricated			
Refrigerant piping & valves installed and tested			
Electrical connections completed			
Disconnect switch installed properly			
Integral operating & safety controls complete & operational			
Starter is installed with proper heaters			
Temperature sensors properly located			
Building controls/DDC system operational			

Filters are installed and are clean			
Uninterrupted electrical power is available from a permanent source			
Ready to start and operate under control			

Startup/Operational Checks Check box for completion	✓	N/A	Comment
Startup by qualified personnel (Gas Cert., Refrigeration Cert.)			
Mechanical, Electrical, and Controls Contractors present			
Fan rotation is correct (bump)			
Firing sequences, safety controls & flame safeguards verified			
Cooling/Heating operation and temperature controls verified			
Proper control operation verified including auto shutdown			

Startup/Operational Checks (Continued) Check box for completion	✓	N/A	Comment
Operation of Electrical & Controls interlocks verified			
Freeze protection is operational			
Combustion efficiency tests performed			
Local air leakage is acceptable			
Compressor Motor Amps: Rated_____ Actual _____ Voltage: Rated_____ Actual _____			
Supply Fan Motor Amps: Rated_____ Actual _____ Voltage: Rated_____ Actual _____			
Vibration/noise level is acceptable			
Equipment has run continuously for a minimum of (4) hours			
Preliminary O&M Manuals provided to Owner			

The above checklist items have been verified complete:

Contractor Name	Signature	Date

The above system/equipment has been verified ready for testing, adjusting and balancing:

Mechanical Engineer Name	Signature	Date

END OF SECTION 230593

SECTION 230700 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 3000, Air Tempering System and Equipment.

1.3 SCOPE

A. Field insulation of piping: see drawings and Part 3 of this specification.

B. Field insulation of ductwork: See drawings, Table 23 0700-1, and Part 3 of this specification.

C. Field insulation of equipment supplied and/or installed under Division 23: See drawings and Part 3 of this specification.

D. Factory-insulated equipment and materials are described on the equipment schedule, on the drawings, and in other sections of this specification.

1.4 SUBMITTALS

A. Submit products to be used including insulation, jackets, miscellaneous products, and products for special applications. Review each application and advise if any product is either not suitable for, or not recommended for the application.

B. Verify that each submitted product meets all requirements for that product as specified herein. Include literature that clearly shows products meet all aspects of the spec. Include a cover sheet or letter with the following statement:

> "Each product submitted here meets all specified requirements for that product except as follows:" followed by a list of any discrepancies.

C. Submit schedules showing the type of product and thickness for each application. Indicate products to be used on valves and fittings. Indicate where vapor barriers will be provided and what jackets will be used.

D. D-5, D-6 & D-7 insulation: If one of these insulations is specified, submit documentation indicating that the submitted materials are approved for the intended service.

E. Submit a description of the application techniques to be used.

1.5 QUALITY ASSURANCE

A. Comply with the latest edition of the National Commercial & Industrial Insulation Standards, as published by the Midwest Insulation Contractors Association.

B. Part 3 and Table 23 0700-1 give the system temperatures for various applications. Supplier shall review these temperatures and confirm the suitability of all components for the specified applications.

C. Test piping and ductwork in accordance with applicable specification sections before insulation is applied.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials must be 100% asbestos-free and 100% formaldehyde-free, NO EXCEPTION.

B. All materials must be GreenGuard Certified, GreenGuard Certified for Children and Schools.

C. Smoke and Fire Ratings: All materials shall have a composite fire and smoke hazard rating not exceeding flame spread 25, fuel contribution 50, smoke developed 50, when tested as assemblies per ASTM Standard E-84 or NFPA 255.

D. Thermal conductivities: Per ASTM C518. Do not exceed the conductivities indicated. Units listed herein for conductivity are Btuh-in/SF-F. Resistance shall not be less than the values specified herein. Units for resistance are SF-F/Btuh.

E. Noise Reduction Coefficients: Per ASTM C423 based on Type A mounting. NRC shall not be less than as specified.

F. Jackets: Maximum 0.02 perm water vapor transmission per ASTM E96 Procedure A.

1. ASJ: All service jacket per ASTM C1136 Type I, paintable white kraft paper outer surface reinforced with glass fiber yarn and bonded to aluminum foil, with self-sealing longitudinal lap and butt strips, breach puncture min. 50 oz-in/in tear per ASTM D781, tensile strength min. 30 lb/in per ASTM D828.
2. FSK: Foil skim kraft per ASTM C1136 Type II.

G. Fiberglass insulation: Inorganic fibers bonded with thermosetting resin.

H. Approved Manufacturers: Owens Corning, Johns Manville, Knauf, Certain-Teed, Kflex, Armacell, Unifrax -Insulfrax, Industrial Insulation Group, Pittsburgh Corning. Where the term

OAE is used herein, this refers to these manufacturers only. No other manufacturers are approved for this project.

2.2 PIPE INSULATION

A. General

1. Valves, Fittings, and Accessories: Use the same insulation materials and thickness as the pipe insulation, except as noted.

B. Type P-1, Fiberglass Pipe Insulation: Factory assembled insulation and ASJ. Pre-formed fiberglass per ASTM C547 Type I, suitable for use on surfaces from 0–850ºF, with thermal conductivity 0.23 at 75ºF or 0.33 at 250ºF, and minimum 3 pcf density. ASJ shall have self-sealing lap at end and along length, with pressure sensitive tape lap sealing system. Owens Corning SSL II Pipe Insulation, Johns Manville Micro-Lok, Knauf Pipe Insulation.

1. Where Type P-1 insulation is used, insulate fittings, valves and accessories using one of the following:

a. Fiberglass pre-formed fitting insulation complying with the specification for P-1 pipe insulation, Johns Manville Hi-Lo Temp insulation inserts, Hamfab, OAE. Finish with Type J-2 fitting covers.
b. Where pre-formed fitting insulation is not available, the following may be used: minimum 0.75 pcf density fiberglass per spec for D-1 insulation except without FSK. Finish with Type J-2 fitting covers or with two coats of fitting mastic with fiberglass fitting tape embedded between coats.

C. Type P-2, Fiberglass Pipe and Tank Insulation: Similar to Type P-1 insulation and jacket, except with fibers oriented to allow insulation to be wrapped onto curved surfaces, with conductivity 0.30 at 100ºF, or 0.55 at 400ºF. Johns Manville Pipe & Tank Insulation, Owens Corning Pipe and Tank Insulation or Knauf Pipe and Tank Insulation.

1. Alternate: Fiberglass board insulation similar to Type D2, scored for application on curved surfaces, with ASJ.

D. Type P-3, Calcium Silicate Pipe Insulation: Rigid calcium silicate per ASTM C533, Type 1, asbestos-free, suitable for use on piping up to 1200ºF, conductivity 0.55 at 700ºF, compressive strength min. 200 psi at 5% compression. Industrial Insulation Group OAE.

1. Fittings, valves and accessories: Insulate with mitered Type P-3 insulation or Type D-7 insulation.

E. Type P-4, Elastomeric Foam Pipe Insulation: Pre-formed elastomeric foam, ASTM C534 Type 1 flexible, closed cell, suitable for use up to 220ºF, UV protected, not to exceed flame spread 25 and smoke developed 50 based on 0.75-inch thickness, conductivity 0.30 at 75ºF. Kflex, Armacell OAE.

1. Fittings, valves and accessories: Insulate using either Type P-4 insulation pre-formed for use on fittings and valves, or cut sections of P-4 pipe insulation to match the shape of the fitting or valve, taped on using PVC tape.

2.3 DUCTWORK INSULATION

A. Type D-1, Fiberglass Blanket: Factory fabricated insulation and FSK jacket assembly suitable for applications from 40-250ºF, 3/4 pcf fiberglass, ASTM C553 Type I or II, with thermal resistance not less than the following for 2-inch thickness: 6.8 out of the box, 5.6 installed with 25% compression. Johns Manville Microlite XG Duct Wrap, Owens Corning Soft R Duct Wrap, Knauf Friendly Feel Duct Wrap, Certainteed Soft Touch Duct Wrap.

B. Type D-2, Fiberglass Board: Similar to Type D-1 except rigid board type, 3 pcf density, thermal conductivity 0.23 at 75ºF, NRC 1.36, suitable for unfaced side at up to 450ºF and faced side at up to 150ºF. Johns Manville 800 Series Spin Glas, Owens Corning 700 Series Board, Knauf Insulation Board, Certainteed Certra Pro Commercial Board

C. Type D-3, Acoustic Lining (roll type): Organic fiber or fiberglass duct liner bonded with thermosetting resin, with factory-applied acrylic surface coating treated with anti-microbial agent, and factory-applied or shop-applied edge coating.

1. Properties: Minimum 1.5 pcf density, thermal conductivity 0.24, 6000 FPM rated per UL 181, NRC 0.70 at 1-inch thick and .95 at 2-inch thick. The product (fiberglass, resin, coating, microbial agent and adhesive) as an assembly shall be suitable for surfaces and gases up to 250ºF, and shall comply with ASTM C1071 (Type I), G21 and G22.
2. Lining surface shall be cleanable using commercially available duct cleaning equipment when performed by qualified technicians using procedures established and recommended by the North American Insulation Manufacturer's Association (NAIMA) Duct Cleaning Guide.
3. Johns Manville Linacoustic RC, Owens Corning Acoustic R duct liner, Knauf EM duct liner, Certainteed ToughGuard R Duct Liner.

D. Type D-4, Acoustic Lining (board type): Similar to Type D-3 and complying with all aspects of the spec for Type D-3 insulation, except 3 pcf density rigid board with NRC 0.75 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Permacote Linacoustic R-300. Owens Corning Duct Liner Board, Knauf Rigid Plenum Liner, Certainteed Rigid Liner Board.

E. Type D-5, Grease Duct Applications: High temperature, foil-encapsulated inorganic blanket, 8 pcf. Insulfrax Fyre Wrap Max 2.0, Johns Manville Fire Temp, OAE. Product shall meet the following when applied as 2-layers around a grease-duct:

1. Tested and listed for zero clearance to combustibles across the entire surface of the blanket material per internal fire test AC101 or ASTM E2336 - Internal Fire Test – 2 Hr Grease Duct Enclosures.
2. Rated as a 2-hr fire resistive enclosure assembly per ASTM E-119, Engulfment Fire Test for 2-hr Grease Duct Enclosure.

F. Type D-6 –Combustible Materials within Plenum: For use on combustible materials located within supply or return air plenums, foil-encapsulated 8 pcf high-temperature ceramic fiber blanket suitable for service up to 1800ºF. Unifrax Fyre-Wrap 0.5 plenum insulation.

G. Type D-7 – Fire Rated Ductwork: Suitable for continuous operation at 1800ºF, 6-pcf, foil-encapsulated inorganic blanket to provide a 2-hour rating per ISO 6944 when applied in a single 1.5-inch thick layer. Insulfrax FyreWrap 1.5 OAE.

H. Type D-8 – Polystyrene Insulation: Rigid cellular square edge insulation per ASTM C578, waterproof, thermal conductivity 0.20, compressive strength 25 psi. Dow Styrofoam or Owens Corning Foamular.

I. Type D-9 – Fiberglass Ductboard: Listed per UL 181 as a Class 1 Rigid Air Duct; conforming to ASHRAE Std. 62, NFPA-90A and 90B, ASTM G-21 & G-22; rated for 2-in. wg; constructed of fiberglass bonded with a thermosetting resin, with double density slip joints pre-molded in the board; FSK jacket; thermosetting acrylic polymer interior surface, and black interior surface color. Thermal conductivity 0.23, and NRC 0.70 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Superduct 475 or 800, Owens Corning Quiet R Duct Board, Knauf Duct Board M, Certainteed ToughGard Duct Board

2.4 EQUIPMENT INSULATION

A. E-1, Removable Insulating Blanket: Factory fabricated, one-piece, removable and re-usable insulating blanket with fiberglass insulation completely enclosed within a silicone coated fiberglass cloth with draw cords of SS or PTFE coated glass fiber, and stainless steel clips. Insulation thickness shall be as specified elsewhere, but not less than 1-inch. Energy Systems Inc. “Q-Master” OAE.

2.5 INSULATION JACKETS

A. Type J-1, Metal Jacket: 0.010-inch smooth Type 304 stainless steel or 0.016-inch smooth or embossed aluminum per ASTM B-209, with minimum 1-mil polyethylene film with protective layer of 40 Lb virgin kraft paper, continuously laminated to full width inside jacket. Childers OAE.

1. Where jacket diameter is 16–96 in: 0.016-in. SS or 0.020 in. aluminum.
2. Equipment heads and all surfaces where jacket is greater than 96-inch OD: 0.020-inch SS or 0.024 inch aluminum.
3. Fittings and Accessories: Provide the same jacket material as for pipe.

B. Type J-2, PVC Jacket: Minimum 20 mil sheets and 30-mil pre-molded fitting covers, ASTM D1784, Class 16354-C. Accessories include solvent weld solution, stainless steel tacks, and tape. All components shall be white, UV resistant, with paintable exterior surface, and suitable for use at –20 to +150ºF. Johns Manville System 2000 (sheets), Zeston 300 (fitting covers), and Perma-Weld (solvent cement), OAE.

C. Type J-3, Canvas Jacket: 10 x 10 fiberglass mesh.

2.6 MISCELLANEOUS PRODUCTS

A. General:

1. Tapes: Aluminum, pressure sensitive, UL 181A-P listed and embossed, minimum 2.5-inch wide, Nashua 324A OAE.
2. Duct Liner Adhesives: Water-based, complying with ASTM C916.

3. Solvent Cement for PVC Jackets: Johns Manville Perma-Weld OAE.
4. Staples: Outward clinching, 0.5-inch galvanized steel

B. Piping Systems:

1. Pipe Hanger Insulation Inserts: Mechanical Pipe Shields Inc. “Snapp Itz” OAE.

C. Ductwork Systems:

1. Duct Liner Edge Sealer, Surface Sealer, Coatings & Adhesives: To meet ASTM C916. Johns Manville Superseal OAE.

2.7 SPECIAL APPLICATIONS

A. Handicap Lavatory Insulation Kit: Handi-Lav-Guard insulation kit per ANSI A117.1 with flexible vinyl finish.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage and Handling: Deliver and store insulation materials in factory-supplied containers. Protect from moisture. Do not install any materials that have gotten wet, regardless whether they are subsequently dried.

B. Store and apply materials in accordance with manufacturers’ recommendations, but not less than the following minimum temperatures. Ensure surfaces are clean and dry prior to application, and for minimum two hours after application:

1. Sealers, coatings, solvents and adhesives: 40^{o}F.
2. Tapes 50^{o}F.

C. Install in accordance with manufacturer’s recommendations, NAIMA recommendations, and this spec. Provide good ventilation.

D. Where vapor barriers are specified, ensure that the entire system is vapor sealed.

E. Protect materials from water damage. Replace any materials that are water-damaged prior to substantial completion.

3.2 PIPING INSULATION

A. General: Insulate piping as indicated herein and/or on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings and accessories. Vapor seal cold piping systems.

1. Where insulation terminates, provide insulating cement beveled for a neat finish. For vaporsealed piping, coat with insulating mastic prior to applying insulating cement.
2. Strainers and Suction Diffusers: Either Type P-1 or P-3 insulation. Make provisions to easily remove and re-install insulation.
3. Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.
4. Penetrations Through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.
5. Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.
6. Steam Traps: Do not insulate.
7. Retrofit Projects: Match the thickness of existing insulation where new insulation adjoins existing. Integrate new vapor barrier with existing so the insulation barrier is continuous for both new and existing piping.
8. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

B. Application:

Temp Range	Temp (F)	Insulation Type	Vapor Sealed	Pipe Size				
				3/4 & Smaller	1 - 1.25	1.5 - 3	4 & 6	8 & Larger
TR-1	< 40	P-1, P-4	Yes	0.5	1	1	1	1.5
TR-2	40 - 60	P-1, P-4	Yes	0.5	0.5	1	1	1
TR-3	61 - 104	P-1	No	0.5	0.5	0.5	0.5	0.5
TR-4	105 - 140	P-1	No	1	1	1.5	1.5	1.5

1. Temperature Range TR-1: Refrigerant Suction
2. Temperature Range TR-2: Not Applicable
3. Temperature Range TR-3: Domestic cold water, non-potable water, HVAC make-up water, interior horizontal roof drain and overflow bowls and piping, condensate drains indoors.
4. Temperature Range TR-4: Domestic hot water (including non-circulating HW within interior walls and chases) and domestic HW return except as noted.
5. Temperature Range TR-5: Not Applicable
6. Temperature Range TR-6: Not Applicable
7. Temperature Range TR-7: Not Applicable
8. Temperature Range TR-8: Not Applicable

C. Special Applications

1. Handicap Lavatories: Insulate domestic hot and cold water piping and P-traps exposed

below handicapped lavatories with insulation kit specifically designed for the application.

2. Heat Traced Piping: Oversize insulation as required to accommodate heat tracing. Provide metal jacket.
3. Plastic pipe in return air plenums: Provide 0.5-inch type D6 insulation.
4. Piping subject to freezing and heat traced piping: Insulate all such piping (including drain piping) with thicknesses specified, but not less than 1.5-inch thickness. Oversize insulation to accommodate heat tracing where indicated. Provide J1 jacket.

D. Type P-1 & P-2, Fiberglass Insulation: Install in accordance with manufacturer's recommendations.

E. Type P-3, Calcium Silicate Insulation: Adhere to pipe or equipment using stainless steel wire. Provide removable J-1 jacket.

F. Type P-4, Elastomeric Foam: Seal all butt ends and longitudinal joints with Halstead Adhesive. When exposed to the weather, protect flexible tubing insulation with two coats of exterior weatherproof coating as recommended by manufacturer.

G. Jacketing: In addition to the finish and jacket specified for the particular type of insulation, provide the following:

1.	Indoor piping exposed to physical damage	Type J-2, PVC
2.	Mechanical Eqpt Spaces: Exposed piping less than 8 ft above floor or operator platform	Type J-2, PVC
3.	Exterior piping	Type J-1, Metal

3.3 DUCTWORK INSULATION

A. General:

1. Insulate all ducts except those specified to be uninsulated. The following ductwork need not be field insulated:

    a. Factory insulated ductwork and plenums.
    b. Ducts with acoustic lining, provided the lining thickness matches or exceeds the required insulation thickness.
    c. Exhaust ducts, except where noted.
    d. Return air ducts, except where noted.

2. See Table 23 0700-1 for additional information.
3. Ensure that ductwork is leakage tested prior to applying insulation. Inspect ductwork and repair any deficiencies prior to applying insulation. Do not apply insulation over deficient ductwork or plenum construction.
4. Ensure that ductwork is clean and dry before applying insulation.
5. For ductwork with acoustic lining the drawings indicate the "clear inside duct dimension" required. Over-size ducts as required to provide the required air flow area.

B. Type D-1, Fiberglass Blanket Insulation: Measure and cut insulation. Install so insulation is not excessively compressed at corners. For rectangular and flat oval ducts 24-inches and wider, provide stick pins and speed clip washers 18-inches on centers on the bottom, and clip off

excess length of stick. Firmly butt insulation ends and longitudinal joints. Overlap jacket minimum 2-inches at end joints and longitudinal joints, staple on 6-inch centers, and continuously seal jacket. Provide vapor barrier mastic where ducts are indicated to be vaporsealed. Should gaps or fishmouths occur, re-staple and seal them with mastic. Use FSK tape and vapor barrier mastic to seal all penetrations of the FSK jacket, such as pins, tears, and hangers. Neatly trim and seal insulation at access doors, ends, damper rod controls etc. Verify proper damper operation.

C. Type D-2, Fiberglass Board Insulation: Attach with mechanical fasteners 12" on centers.

D. Type D-3 & D4, Acoustic Lining: Ductwork dimensions indicated on the drawings are net air flow dimensions inside liner. Increase duct size to accommodate liner. Completely line the inside surfaces of ducts and plenums specified and indicted. Comply with the NAIMA Fibrous Glass Duct Liner Standard (FGDLS), manufacturer's recommendations, and this spec. Adhere liner with minimum 90% coverage of adhesive, and secure with mechanical fasteners and washers per FGDLS and manufacturer's recommendations. Fastener length shall be sufficient to limit compression of liner to 1/8" maximum. Coat all cut edges and surface penetrations with edge sealer. Provide metal nosing for liner leading edges at fan discharge and for all ducts with air velocities exceeding 3,000 FPM. Maintain minimum 18-inch clearance from electric resistance heaters. Interrupt liner at dampers and apply external insulation at these locations.

1. Provide Type D-3 insulation for the 10 feet upstream of roof exhaust fans except in wet air streams.

E. Type D-5: Install insulation in a 2-layer system per manufacturer's instructions, including the use of mechanical fasteners for the underside of ducts, butting or overlapping of joints, and offsetting of joints on outer layer.

F. Type D-6: Install in accordance with manufacturer's instructions. Overlap seams and joints minimum 2-inches, affix with SS wire minimum 18-inches on centers, but not less than per manufacturer's recommendations, and tape seams and joints with aluminum tape.

G. Type D-7: Install insulation in a single-layer system per manufacturer's instructions. Mechanical fasteners for the underside of ducts shall be adhered to the duct in a manner suitable for the operating temperatures (welded or other suitable method). Butt or overlap joints per manufacturer's recommendations.

H. Type D-8: Wire in place with SS wire minimum 12-inches on centers, and provide J-1 jacket.

I. Type D-9: Install per manufacturer's recommendations, NAIMA standards, and SMACNA Fibrous Glass Duct Construction Standards. Provide ship lap seams and joints.

3.4 EQUIPMENT INSULATION

A. General: Where specified elsewhere, equipment will be factory insulated. Insulate all equipment as noted herein except portions of equipment that are factory insulated.

1. Fiberglass Board Insulation: Score, bevel, or miter to provide tight joints and secure in place with mechanical pin and clip fasteners and insulation bonding adhesive applied to underside surfaces, or with bands. Fill joints with insulation material and provide corner

beads to protect edges of insulation.

2. Cold Tanks and Equipment: J3 jacket with two coats of approved vapor barrier mastic.
3. Factory Packaged Equipment: Field insulate the equipment and piping on factory-fabricated assemblies as if they were field installed, unless such items are factory insulated.

3.5 JACKETING

A. Type J-1, Metal Jacketing:

1. Ducts: Slope jacketing to shed rain.
2. Pipes: Install with seams at the 3 o'clock or 9 o'clock position to shed water. Band 12" on centers.
3. Joints and Seams: Overlap joints minimum 2-inches. Caulk with a weatherproof caulk when located outdoors.

B. Type J-2, PVC Jacketing: Secure in place with tacks and solvent welded joints. White PVC tape may be used indoors.

C. Type J-3, Canvas Jacket: Apply mastic at a rate of 60 to 70 sq. ft. per gallon, embed fiberglass mesh, smooth all wrinkles and apply finish coat of Sealfas, or equivalent.

END OF SECTION 230700

TABLE 23 0700-1 ─ DUCTWORK INSULATION

Service	Location	Condition	Insulation Type	Insulation Thickness (in)	Notes
Supply Air, Makeup Air, Outside Air	Indoor	Concealed	D1	1.5	1, 6
Supply Air, Makeup Air, Outside Air	Indoor	Exposed	D2	1.5	
Supply Air, Makeup Air, Return Air	Outdoor	All	D8	2	2, 4, 7
Supply Rectangular Ductwork downstream of Terminal Units, Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	Indoor	All	D1	1.5	1, 3
Return Rectangular Ductwork upstream of Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	All	All	D1	1.5	1, 3
Ductwork indicated to be lined	All	All	D3	1	
Ductwork indicated to be lined with 2-inch acoustic lining	All	All	D3 or D4	2	
Single Wall Lined Plenums	All	All	D4	2	
Transfer Air Ducts	All	All	D3 or D9	1	
Exhaust Ductwork	Indoor	Concealed	D1	1.5	8
Exhaust Ductwork	Indoor	Exposed	D2	1.5	8
Kitchen Exhaust Ductwork	Indoor	All	D5	2-layers	
Plastic Piping and Ductwork within RA Plenums	Indoor	Concealed	D6	0.5	
Fire-Rated Ductwork Other than Kitchen Exh	Indoor	All	D7	1.5	
Boiler Breeching & Stack	Indoor	All	P1 or P2	3	
Boiler Breeching & Stack	Outdoor	Exposed	P1 or P2	3	4, 7

Notes:
1 Includes Supply Air Duct from Energy Recovery Units and Evaporative Coolers.
2 Provide acoustical liner as indicated on the drawings.
3 Delete Type D1 insulation if acoustical liner is indicated by plan notes or shown on the drawings.
4 Provide J1 Jacket.
5 Not Applicable.
6 Vaporseal ducts conveying cold air.
7 Seal outdoor ductwork to prevent ingress of moisture.
8 Insulate only the portion of exhaust ductwork between isolation damper and outside.

SECTION 230810 - PERFORMANCE ASSURANCE FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, general project requirements and Division 01 Specification Sections, apply to this Section. Note in particular the following sections containing related requirements:

1. General Conditions – Article 6: Contractor's responsibilities to cooperate and coordinate with Owner's separate contractors.
2. Section 01 3100 – Project Management and Coordination: Coordination of Performance Assurance work; inclusion in Project Schedule.
3. Section 01 4000 – Quality Requirements: Performance Assurance Contractor's (PAC) services and reports; Contractor's responsibilities.
4. Section 01 7500 – Starting and Adjusting: Coordination with PAC requirements.
5. Section 01 7700 – Closeout Procedures: Coordination with PAC requirements.
6. Section 01 7800 – Closeout Submittals - Coordination with PAC requirements.
7. Section 01 7900 – Demonstration and Training
8. Section 23 0593 – Testing, Adjusting, and Balancing
9. Section 01810 – Performance Assurance Contractor Requirements
10. Section 23 0900 – Automatic Temperature Controls

1.2 SCOPE OF WORK

A. This section includes Owner's separate Performance Assurance Contractor (PAC) process requirements related to HVAC systems, assemblies, and equipment. The Contractor shall provide the necessary labor, instrumentation, tools and equipment for this portion of the Work.

1.3 DEFINITIONS

A. Performance Assurance Contractor: Performance Assurance Contractor Authority: An independent consultant, not otherwise associated with the Design Professional team members or the Contractor who is hired by, and reports directly to the Owner in accordance with Article 6 of the General Conditions.

1.4 CONTRACTOR'S SUBMITTALS

A. General: Comply with the provisions of the General Conditions of the Contract and Division 01 specification sections.

B. Product Data: Submit directly to PAC, with copies to Design Professional and Owner:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports required by PAC requirements on Project.
2. Identification of installed systems, assemblies, equipment, and components, including design changes that occurred during construction.
3. Process description and schedule for completing construction checklists and manufacturer's pre-start and start-up checklists for HVAC systems, subsystems, equipment, and components to be tested.
4. Certificate of completion certifying that the HVAC systems, sub-systems, equipment, and associated controls are ready for testing.
5. Certification of readiness certifying that HVAC systems, sub-systems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents with follow-up and results.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Equipment required for start-up, checking, and testing shall be calibrated within the past year and in accordance with the manufacturer's recommendations.

PART 3 - EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITIES

A. Upload requested information and submittals to Unifier including, but not limited to:

1. Performance data
2. Capacity information
3. Sequence of operations
4. Factory performance tests
5. IOM manuals

B. Complete pre-functional checklists (PFC's) as directed by the Performance Assurance Contractor.

C. Perform functional performance testing (PFT's) as directed by the Performance Assurance Contractor.

D. Attend construction phase controls coordination meeting.

E. Attend testing, adjusting, and balancing review and coordination meeting.

F. Participate in HVAC systems, assemblies, equipment and component maintenance orientation and inspection as directed by the Performance Assurance Contractor.

G. Provide information requested by the PAC for final PAC documentation.

3.2 CONTRACTOR'S TESTING PREPARATION

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

B. Certify HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

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

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

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

F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the Performance Assurance Contractor.

3.3 CONTRACTOR'S GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform Performance Assurance tests at the direction of the Performance Assurance Contractor.

B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

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

D. The Performance Assurance Contractor along with the Plumbing and HVAC Subcontractor, and HVAC Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment. All parties are to sign off on agreed upon plans.

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

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the Performance Assurance Contractor and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The Performance Assurance Contractor may direct that set points be altered when simulating conditions is not practical.

H. The Performance Assurance Contractor may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUB-SYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. HVAC Instrumentation and Control System Testing: Contractor shall assist the Performance Assurance Contractor with preparation of testing plans.

B. Contractor shall prepare an HVAC-associated pipe system cleaning, evacuation, purging, and pressure testing plan. This work shall be performed according to the equipment manufacturers recommended procedures for R410a refrigerants. Provide cleaning, evacuation, purging, and pressure testing plan and final reports to the Performance Assurance Contractor. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, evacuation purging, and pressure testing.
2. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, purged, and pressure tested.

C. Refrigeration System Testing: Contractor to provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The Performance Assurance Contractor shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

D. HVAC Distribution System Testing: Contractor to provide technicians, instrumentation, tools, and equipment to test performance of air, special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.

END OF SECTION 230810

SECTION 230900 - AUTOMATIC CONTROLS FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Special Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0505, Piping Specialties.

C. Section 23 0523, Valves.

D. Section 23 0549, HVAC and Electrical Installation Coordination.

E. Section 23 0593, Testing, Adjusting and Balancing.

F. Section 23 0810 Performance Assurance Contractor HVAC Systems.

1.3 SCOPE

A. It is the intent of this section to provide a fully functional system to provide fully automatic temperature control for all systems provided under this contract.

B. It is the responsibility of the bidder to read and conform to all sections of the specifications, review all contract drawings and to coordinate all equipment supplied under other sections of the specifications with this work.

C. The control system shall include all operator input/output devices, field control units, field controls, sensors and controls conduit, wiring, and piping, etc.

D. The engineering, installation supervision and labor, calibration, and checkout necessary for a complete and fully operational control system as specified hereafter shall be provided under this section.

E. The controls contractor shall be responsible for installation of factory furnished and field installed controls as well as all other system controls indicated on the contract drawings or required by this specification.

1.4 PRIOR APPROVAL

A. No DDC contractor is required for this project, prior approval and qualifications for DDC controls system and installation is not required. The Division 23 contractor shall be responsible for installation of thermostats, time clocks, and low voltage wiring (<51 volts). All power wiring and terminations greater than 50 volts shall be provided by Division 26. Division 23 shall provide the PSFA measurement and verification meters, control wiring indicated in this specifications and mechanical drawings. All additional sensors for electrical meters shall be furnished by Division 26 and connected to the Quickserver system per this specification. All wiring associated with electrical meters and connection to the Quickserver shall be by division 26 contractor. .

1.5 SUBMITTALS

A. Submittals shall be provided as required by 23 0500 and the General Contract Requirements. Submittals shall consist of shop drawings and catalog data sheets. Shop drawings shall show all controlled devices, electrical ladder diagrams, system schematics, sequence of operation, and material lists.

B. Within 30 days of contract award, submit eight sets of shop drawing and submittal data. These submittals shall be provided to the Mechanical and Electrical sub-contractors for co-ordination review and evaluation prior to being submitted to the Owner's authorized representative. Letters from these sub-contractors verifying that they have reviewed the submittals and including any comments must be attached with submittals when submitted to Owner's authorized representative. Submittals received without such reviews will be returned without action.

1.6 SHOP DRAWINGS

A. Shop drawings shall be provided which show all controlled systems and control devices. Connections between all components shall be clearly indicated. Control contractor shall coordinate with other suppliers prior to submitting so that final connections to all equipment can be shown. Simply showing a connection with no identification or termination will be considered unacceptable. All connections shall be labeled on both ends and these same labels shall be used for the installation process. Each device shall also be given a unique identifier. This identifier shall be used in the sequence of operation so that reference to the drawings can be easily made.

B. Electrical Ladder Diagrams shall be provided on the shop drawings which show the correct control wiring and interlock wiring of all equipment provided by Division 23 and other equipment required including air handling units, boilers, chillers, etc. including owner furnished equipment and equipment under other sections of this specification. Diagrams shall show all switches, relays, motor starters, etc. Each diagram shall reference the correct power source, whether from a specific circuit or from a control transformer. If equipment shown is provided by another contractor, then this shall be noted. Any relevant set points, such as time delay relay settings, shall be shown.

C. The sequence of operation for each controlled system shall be provided with reference to

the control device identifier. The sequence of operation shall break down the control operation by major function (i.e., mixed air control, occupied-unoccupied, smoke purge, etc.) and describe in detail the correct operation and interaction with other system functions.

D. A complete material listing shall be included on the shop drawings which show the device model number, device identifier, quantity, manufacturer, etc., of all equipment provided by this contractor. The material list shall be organized in alphabetical order so that it can be easily compared to the associated catalog data sheet. The quantities are to be provided only to confirm a general understanding of the contract requirements and will not be verified as a complete material list.

1.7 CATALOG DATA SHEETS

A. A manufacturer's catalog data sheet will be provided for each piece of equipment provided by this contractor. At a minimum, the data sheet shall contain sufficient information so that compliance with the specification can be verified. The catalog data sheets shall be organized in alphabetical order to match the material listing on the shop drawings.

1.8 RECORD DRAWINGS

A. Record drawings shall be provided as required by 23 0500 and the General Contract Requirements. Record drawings shall not be completed until after installation is complete. Any changes made during installation shall be recorded on the submittal drawings so that a current record drawing is constantly being updated. At completion of the project, all changes shall be incorporated into a clean record drawing version. These record drawings shall be detailed enough to thoroughly trouble-shoot the entire system.

B. With the reproducible record drawings the Contractor shall furnish a complete spare parts lists, operating instructions, and maintenance literature, for proper maintenance of all control equipment, in accordance with the requirement specified in Section 23 0500.

C. The following manuals or combination manuals will be provided 2 sets:

1. An operator's manual which will include detailed instructions for all operations associated with the Automatic Temperature Controls System.

1.9 TEST AND INSTRUCTION

A. The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to and during functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

1. System name.
2. List of devices.

3. Step-by-step procedures for testing each controller after installation, including:

    a. Process of verifying proper hardware and wiring installation.
    b. Process of performing operational checks of each controlled component.
    c. Plan and process for calibrating valve and damper actuators and all sensors.
    d. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
5. A description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to Testing, Adjusting and Balancing (TAB) using the control system for TAB work. Coordinate with the Owner and TAB contractor for this determination.

B. Upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, provide a signed and dated certification to the Owner and GC that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.

C. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air and water pressure).

D. The Owner reserves the right to participate in or assign a representative to participate in the startup, testing, programming, or any other aspect of the construction of this project at no additional cost to the Owner.

1.10 TRAINING

A. Upon completion of the work and acceptance by the Owner, the contractor shall provide training of thermostat programming, timeclock programming and associated equipment function. The contractor shall provide 8 hours total of on site instruction to the Owner's operating personnel who have responsibility for the mechanical system.

1.11 SERVICE AND WARRANTY

A. The system supplier shall maintain a local maintenance support facility complete with system technicians, diagnostic and test equipment, and new spare components. Emergency service shall be available in the local office on a 24-hour, 7-day a week basis. The service agent shall provide a continuously monitored local service telephone number for emergency service and this number shall be provided to the Owner.

B. Warranty all work as follows:

1. Labor & materials for control system specified shall be warranted free from

defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. Service during this period shall be available within 12-hours from the time the trouble call is placed.

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.

C. Service and maintenance must be provided for one year minimum from time of owner acceptance of the system with 12-hour response time. Warranty shall be for full system component parts and labor.

1.12 PROGRESS PAYMENTS

A. When developing a schedule of values for the automatic temperature control systems, a minimum of 2 weeks shall be reserved for activities after construction completion, including commissioning support, testing (functional performance testing as required herein), record drawings, training, etc. Payment for these activities may be requested as they are completed.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products required for this project not provided with the factory controls systems shall be selected in accordance with this Part of the Section. Installation of the components shall be in accordance with Part 3 of the Section. If a component is required to meet the requirements shown on the drawings and is not specified in the Part of the specification, the Supplier shall select and submit on components that meets all design requirements indicated on the Drawings, stated in the sequence of operation, and elsewhere in the Contract documents.

2.2 ROOM THERMOSTAT

A. WI FI Electronic Programmable Thermostat (Single & Multi-Stage): Electronic programmable thermostats shall be fully configurable single piece commercial design with sub-bases provided for required application operating on a maximum voltage of 24 VAC. Programmable temperature range shall be 55^{O}F to 85^{O}F and schedules shall be in 1 hour increments. Shall be capable of two occupied and two unoccupied intervals per day plus weekend and holiday schedules. Occupancy override shall be located on the thermostat to allow for two hour override of the occupied mode, setpoint limiting, and setpoint lockout. Each thermostat shall be furnished and installed with a Wi-Fi connection to the schools Wi-Fi network. –Honeywell – WI-FI Vision Pro Thermostat Model# TH8321WF1001. No exceptions. (Owner will provide graphics and IP addresses

and connection for each thermostat location).

1. Exception – Packaged Split System for Electrical, Data, etc shall have thermostats furnished with split systems.

B. Line Voltage Thermostat: The thermostat shall be of the bimetallic design with a SPDT set of contacts rated for 120 VAC at 25 amps. Thermostat shall have an adjustable set point of from 50 deg F to 86 deg F with a fixed differential of 2.0 deg F.

2.3 CONTROL RELAYS

A. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contracts, enclosed in dustproof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.

2.4 SMOKE AND FIRE DETECTORS

A. Smoke detectors shall be supplied, powered, installed, and interlocked in accordance with Section 23 0549. The smoke detectors shall be listed by Underwriters' Laboratories, Inc. The units shall be designed for detection of combustion gases, fire and smoke in air conditioning and ventilation system ducts, in compliance with the National Fire Protection Association, Recommended Practices Pamphlet No. 90A. It shall consist of an ionization type detector with self-contained control unit. The assembly shall consist of a casting to accommodate metallic sampling tubes which extend across the duct of the ventilation system.

B. The unit shall provide two (2) sets of normally open single pole, double throw alarm operated relay contacts (5A, 120V, AC).

C. The unit shall be bolted directly to the duct or plenum wall. A template shall be provided for making necessary cutouts and holes. Complete instructions shall be provided with units.

D. Unit shall be capable of stable operation from 0 deg to 150 deg F.

E. Sampling tubes shall be EMT tubing, 1/2-inch in diameter, length and support as required to extend across plenum or duct. Quantity and location of sampling tubes shall be as required for representative sampling. Plastic tubes will not be allowed.

2.5 WIRING

A. Provide interlock wiring between supply and exhaust fans, electrical wiring for relays (including power feed) for temperature and pressure indication. Provide interlock wiring between refrigeration machines, and condensing equipment as required for the specified sequence of operation and the refrigeration system integral controller(s).

B. Provide power wiring, conduit and connections for low temperature thermostats, high

temperature thermostats, alarms, flow switches, actuating devices for temperature, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by the factory controls and field installed.

C. Provide all other wiring required for the complete operation of the specified systems including control power wiring not expressly stated to be provided by Division 26.

D. Install all wiring raceway systems complying with the requirements of the National Electrical Code and Division 26. All installations shall be installed in EMT.

E. Thermostat and Time Clock Control Wiring

1. Per equipment installation manual requirements.

F. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
3. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

2.6 EQUIPMENT CONNECTIONS

A. Not Applicable.

2.7 HVAC SYSTEM TIMECLOCK

A. Timeclocks shall be 365-day astronomic type with the following features:

1. Automatic input voltage selection from 120 to 277 VAC, 50/60 Hz.
2. NEMA 1 Metal Enclosure
3. Over 2,000 events plus holiday schedules.
4. Advanced scheduling including relative dating, such as fourth.
5. 30 A rated contacts.
6. 100-hour supercapacitor eliminates the need for batteries.
7. USB connection for uploading, downloading and transferring programs.
8. Easy-to-follow on-screen menus for programming to-the-minute accuracy
9. Non-volatile memory protects programming indefinitely
10. Firmware upgradable in-field via USB or Ethernet
11. Internally expandable, in 4-circuit increments, up to 16-circuits for 4, 8, and 12-circuit models

12. PC App for easy scheduling or control, either remotely or through USB flash drive

B. Timeclocks shall be Intermatic Model ET90215C or equivalent.

2.8 ELECTRONIC LIQUID FLOWMETER

A. The flowmeter shall be of the inline electromagnetic type which installs into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow and remote digital display. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall be 24 VAC powered. Meter shall be Meter shall include all necessary gaskets required for installation into the system. Flow meter shall be installed within the manufacturer's required straight pipe lengths for accuracy. Flow meter shall be Onicon F-3100 or equivalent.

2.9 GAS SUB-METER

A. The flow meter shall be hand-insertable up to 250 psi. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall provide SFPM flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation. In addition, the meter shall continuously display information that can be used to validate the calibration of the meter. Each flow meter shall be individually wet-calibrated against a standard that is directly traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Provide flow meter assembly complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown.

B. Accuracy shall be within ± 1% of rate from 500-7000 SFPM and ± 2% of rate from 100-500 SFPM. Overall turndown shall exceed 1000:1. Output signals shall consist of the following: (1) analog 4-20mA output and (1) scalable pulse output for totalization. The meter shall be equipped with an integrally mounted graphical display that may be optionally remote mounted up to 1000 ft from the sensor. Each flow meter shall be covered by the manufacturer's two-year warranty. Provide an ONICON Model F- 5200 Insertion Thermal Mass Flow Meter. Meter shall be rated for outdoor application.

2.10 MEASUREMENT AND VERIFICATION SYSTEM

A. The contractor shall provide a new Measurement &Verification (M&V) monitoring system which is in accordance with PSFA requirements. The system shall consist of electric meters, gas meter, and domestic water meter which connect to a FieldServer which will transfer this information to an offsite central server.

B. Furnish and install a FieldServer QuickServer model FS-QS-1010-0593 (BACnet IP, Modbus RTU, HTTPS-XML) or FS-QS-1010-1140 (BACnetIP, Modbust RTU, Modbus TCP, HTTPS-XML). The QuickServer shall be furnished with Accessory Kit model FS-8915-36-QS containing a power supply, DIN mounting bracket, Ethernet cable, and USB flash drive.

C. Furnish and install dual communications output Flow Display Onicon model D-100-RTU with MODBUS RTU RS485 and BACnet interface and standard 24VAC power requirement. All meters shall have the following variables:

Value Name	Value Description	Format	Units	# Required
Volume Rate (Flow Rate)	Volume Rate – L/Sec. (water)	Floating Point Register	Liters/Second	2
Totalized Volume (Total Flow)	Volume Total Mode 1 – M3 (water)	Floating Point Register	Cubic Meters	2
Auxiliary Input Total (Di3)	Volume Total (Gas)	Floating Point Register	-	2
Gas Generate Rate (Ai3)	Mass Flow (Gas)	Floating Point Register	-	2

2.11 MEASUREMENT AND VERIFICATION POWER METERS

A. The meter shall be UL listed and CE marked.

B. The meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The meter shall perform to spec in harsh electrical applications in high and low voltage power systems.

1. The meter shall support 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
2. The meter shall accept universal voltage input.
3. The meter's surge withstand shall conform to IEEE C37.90.1.
4. The meter shall be user programmable for voltage range to any PT ratio.
5. The meter shall accept a burden up to 0.36VA per phase, Max at 600 V, and 0.014 VA at 120 Volts.
6. The meter shall accept a voltage input range of up to 576 Volts Line to Neutral, and up to 721 Volts Line to Line.
7. The meter shall accept a current reading of up to 11 Amps continuous.
8. The meter shall have color-coordinated voltage and current inputs.
9. The meter shall have a phasor diagram, through software, that clearly shows wiring status.

C. The meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter. The second method shall provide additional termination pass through bars, allowing the CT leads

to be terminated on the meter. The meter must support both termination methods.

1. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
2. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.
3. The meter shall accept a burden of 0.005 VA per phase, Max at 11 Amps.
4. The meter shall begin reading at 0.1% of the nominal current.
5. Pass through wire gauge dimension of 0.177" / 4.5 mm shall be available.
6. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.
7. The meter shall accept current inputs of class 10: (0 to 10) A, 5 Amp Nominal, and class 2 (0 to 2) A, 1 Amp Nominal Secondary.

D. Multifunction, Data-Logging, Power and Energy Meter with Advanced I/O and Power Quality

1. The meter shall have an accuracy of +/- 0.1% or better for Volts and Amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2%) and ANSI C12.20 (Class 0.2%). The meter shall have a Frequency measurement accuracy of not less than 0.001 Hz.

    a. The meter shall provide true RMS measurements of voltage, - phase to neutral and phase- to-phase; and current, per phase and neutral.
    b. The meter shall calculate RMS readings, sampling at over 400 samples per cycle on all channels measured readings continuously with no cycle blind spots.
    c. The meter shall utilize 24 bit Analog to Digital conversion.
    d. The meter shall provide %THD (% of Total Harmonic Distortion). Harmonic magnitude recording to the 40th order shall be available for voltage and current harmonics.

2. The meter shall provide a simultaneous voltage and current waveform recorder.

    a. The meter shall be capable of recording 512 samples per cycle for a voltage or swell, or for a current fault event.
    b. The meter shall provide pre- and post-event recording capability.
    c. The meter shall have a programmable sampling rate for the waveform recorder.
    d. The meter shall have an advanced DSP design that allows power quality triggers to be based on a 1 cycle updated RMS.
    e. The meter shall allow up to 170 events to be recorded.
    f. The meter shall store waveform data in a first-in, first-out circular buffer to insure that data is always being recorded.

3. The meter shall include a three-line, bright red, .56" LED display.

    a. The meter shall fit in both DIN 92 mm and ANSI C39.1 round cut-outs.
    b. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.

4. The meter shall be available in transducer only version, with no display.

    a. The meter shall mount directly to a DIN rail and provide RS485 Modbus or DNP 3.0 output.

5. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
6. Power meter shall include virtual measurement upgrade packs (V-Switch™ keys), which shall allow user to upgrade in field without removing installed meter.

    a. The six Virtual Upgrade packs shall be:

        Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, and I/O Expansion - V1 Above with 2 Megabytes of memory for Data-logging - V2

        Above with Power Quality Harmonics - V3
        Above, with Limit and Control Functions - V4

        Above, with 64 samples per cycle Waveform Recorder and 3 Megabytes of memory for Data-logging - V5

        Above, with 512 samples per cycle Waveform Recorder and 4 Megabytes of memory for Data-logging - V6

    b. The V-Switch™ keys must be able to be implemented without physically removing the installed meter.

7. The meter shall include 2 independent communications ports on the back and face plate, with advanced features.

    a. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.
    b. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.
    c. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a PDA or remote laptop without need for a communication cable.

8. The meter shall provide user configured fixed window or rolling window demand. This shall allow the user to set up the particular utility demand profile.

    a. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
    b. All other parameters shall offer max and min capability over the user selectable averaging period.
    c. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
    d. The meter shall provide an update rate of every 6 cycles for Watts, VAR and VA. All other parameters shall be every 60 cycles.

9. The meter shall support a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available and shall have a burden of less than 11 VA. An optional power supply of 18-60 Volts DC shall be available.
10. The meter shall provide Limits Alarms and Control Capability as follows:

    a. Limits can be set for any measured parameter.

b. Up to 16 limits can be set.
c. Limits shall be based on % of Full Scale settings.
d. Manual Relay Control shall be available through software.
e. Relay set delays and reset delays shall be available.
f. Relay control shall be available through DNP over Ethernet with the Ethernet Option card.

11. The meter shall have data logging capability with the 2, 3, and 4 Megabyte memory upgrade (Virtual Upgrade packs 2-6). The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter with Virtual Upgrade packs 2-4 shall have six logs; the meter with Virtual Upgrade packs 5 and 6 shall also have the Waveform Log:

    a. The meter shall have three historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs.
    b. The meter shall have a log for Limits Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording to 2048 events.
    c. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes, and Critical Data Repairs.
    d. The meter shall have a log for I/O changes. The I/O Change log shall provide a time- stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.
    e. The meter with Virtual Upgrade packs 5 and 6 shall have a log which is capable of recording a waveform both when a user-programmed value goes out of limit and when the value returns to within limit.

12. The meter shall have I/O expandability through two Option card slots on the back.

    a. The cards shall be capable of being installed in the field, without removing the meter from installation.
    b. The meter shall auto-detect the presence of any I/O Option cards.
    c. The Option card slots shall accept I/O cards in all of the following formats: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Output/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card.
    d. The meter shall be capable of accepting any combination of up to two cards.
    e. When two Ethernet cards are installed in the meter, an independent IP address and MAC address shall be assignable to each card.
    f. The Ethernet Option Card shall provide the meter with 100BaseT Ethernet functionality. The Ethernet Option card shall:
    Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
    Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously.

Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously. Allow auto transmit/receive detection for straight or null RJ45 cables.
Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.
Provide email on configured alarms.
Provide email notification of meter status and readings data on a programmed schedule.

g. The 1mAO Option Card shall provide the following features: 4 channel, bi-directional 0-1mA outputs.
Assignable to any measured parameter.
0.1% of Full Scale accuracy throughout range and load.
Maximum load impedance to 10k Ohms, with no accuracy losses.

h. The 20mAO Option Card shall provide the following features: 4 channel, 4-20mA outputs.
Assignable to any measured parameter.
0.1% of Full Scale accuracy throughout range and load.
Maximum load impedance to 850 Ohms, with no accuracy losses. Loop powered using up to 24 Volts DC.

i. The Relay Output/Status Input Option Card shall provide the following features: 2 Relay outputs, 2 Status inputs.
Status Inputs – Wet/Dry Auto Detect up to 150 Volts DC.
Trigger on User Set Limits/Alarms (with Virtual Upgrade pack 4). Set delays and Reset delays.

j. The Pulse Output/Digital Input Option Card shall provide the following features: 4 KYZ pulse/4 Status inputs.
Programmable to any energy parameter and pulse value.
Programmable to End of Interval pulse.
Can function for manual relay control and limit based control (with Virtual Upgrade pack 4).
120mA continuous load current.
DNP input.

k. The Fiber Optic Option Card shall provide the following features:
Built in logic to mimic RS485 half-duplex bus, allowing the user to daisy chain meters for low installation cost.
ST Terminated Option.
Versatile Link Terminated Option.
Modbus and DNP 3.0 protocols available.

l. The IEC 61850 Protocol Ethernet Network Option Card shall provide the following features:
Integrates into any IEC 61850 network.
Provides support for Modbus and IEC 61850 protocols simultaneously.
Configurable for multiple logical nodes.
Provides buffered and unbuffered reporting.
Provides dual Ethernet IEC 61850 Protocol Network option cards. Is certified by a 3rd party Authorized IEC61850 Test Laboratory.
Is capable of supporting two Ethernet /IP connections with separate /IP addresses, each running IEC 61850 protocol.

13. The meter shall have transformer loss, line loss, and total substation loss compensation.

    a. Substation losses shall be programmable for Watts and VARs, and for Ferris and copper losses.
    b. The meter shall have CT and PT compensation to set compensation factors for errors in CTs and PTs connected to the meter.

14. The meter shall have a standard 4-year warranty.
15. Power meter shall be able to be stored in (-20 to +70) degrees C.

    a. Operating temperature shall be (-20 to +70) degrees C.
    b. NEMA 1 faceplate rating shall be available for the power meter.

16. Acceptable product is Electro Industries/GaugeTech, Model: Shark®200-60-10-V5-D2-INP100S- X.

E. Multifunction Power and Energy Meter

1. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC687 (class 0.2%) and ANSI C12.201(Class 0.2%).

    a. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.
    b. The meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
    c. The meter shall utilize 24 bit Analog to Digital conversion.
    d. Meter shall provide Harmonics %THD (% of total Harmonic Distortion).

2. The meter shall include a three line, bright red, .56” LED display.

    a. The meter shall fit in both DIN 92mm and ANSI C39.1 Round cut-outs.
    b. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.

3. Meter shall be available in transducer only version, which shall not include a display.

    a. The meter shall mount directly to a DIN rail and provide RS485 Modbus or DNP 3.0 output.

4. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy
5. Power meter shall include virtual measurement upgrade packs, which shall allow user to upgrade in field without removing installed meter.

    a. Four upgrade packs shall be:

        1) Volts and Amps Meter – Default
        2) Volts, Amps, kW, kVAR, PF, kVA, Freq.
        3) Volts, Amps, kw, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh.

4) Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, %THD Monitoring and Limit Exceeded Alarms.

b. These virtual upgrade packs must be able to be updated without physically removing the installed meter.
c. Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.

6. The meter shall include 2 independent communications ports on the back and face plate, with advanced features.

a. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.
b. Baud rates shall be from 9,600 baud to 57,600 baud.
c. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a remote laptop PC without need for a communication cable.
d. Meter shall have 8 Bit, No parity.

7. The meter shall have optional 100BaseT Ethernet communication capability.

a. Ethernet communication shall consist of Modbus protocol over TCP/IP.

8. The meter shall provide user configured fixed window or rolling window demand. This shall allow user to set up the particular utility demand profile.

a. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
b. All other parameters shall offer max and min capability over the user selectable averaging period.
c. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

9. The meter shall support power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available.

a. Meter power supply shall accept burden of 10VA max.
b. Meter shall provide upgrade rate of 100msec for Watts, Var and VA. All other parameters shall be 1 second.

10. The meter shall have a standard 4-year warranty.

11. Power meter shall be able to be stored in (-20 to +70) degrees C.

a. Operating temperature shall be (-20 to +70) degrees C.
b. NEMA 12 faceplate rating shall be available for the power meter.

12. Acceptable product is Electro Industries/GaugeTech, Model: Shark 200

PART 3 - EXECUTION

3.1 GENERAL

A. All devices, conduit, wiring, etc., shall be installed in a neat professional manner by skilled persons.

1. The installation of all aspects of the system shall comply with all applicable codes and regulations and with Division 26 Specifications.
2. The installation of all materials shall be in accordance with the published manufacturer's recommendations without exception. If for some reason a particular component cannot be installed in compliance with these recommendations, the Contractor shall advise the Engineer of the situation.
3. Where miscellaneous materials are required to complete an installation, i.e., isolation valves for pressure switches, wall switches for an exhaust fan control circuit, etc.; the materials shall be supplied as defined in the relevant Section of these Specifications. For example, Section 23 0523 specifies valve requirements, and Division 26 specifies electrical products and requirements.
4. Coordinate with other trades where installation of a particular component requires other trades to be involved. Installation coordination includes location the correct placement of thermowells, flow switches, dampers, control valves, control power circuits, etc. Care must be exercised to identify locations that meet the requirements of the manufacturer including upstream and downstream distances, pressures, temperatures, etc.

3.2 THERMOSTATS

A. Thermostats shall be installed 44" A.F.F. to the center of the thermostat unless otherwise noted on the architectural drawings or specifications.

B. Provide locking thermostat cover for thermostats located in common areas and hallways.

3.3 CONTROL RELAYS

A. Control relays shall be field or panel mounted as indicated on the Drawings. If a relay is field mounted it will be installed in a NEMA I housing.

B. Control relays shall be installed in bases and the based mounted on a DIN rail. All accessories including end clips, jumpers, etc., shall be provided. All wiring shall be labeled. Multiple conductors shall be bundled and run by classification in plastic wireways. Relays shall be labeled as indicated in the shop drawings for ease in troubleshooting.

3.4 SMOKE AND FIRE DETECTORS

A. Smoke detectors and the associated wiring shall be installed in accordance with Section 23 0549.

3.5 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Comply with all Division 26 installation requirements.

B. Install low voltage power in conduit in the following locations regardless of local building code allowances otherwise.

1. Mechanical rooms.
2. Electrical rooms.
3. Vertical risers. (Exception: fire rated continuous closet like a telephone closet.)
4. Open areas where the wiring will be exposed to view or tampering.
5. Hard ceilings and walls.

C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

D. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

E. All wire-to-device connections shall be made at terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

F. Plug or cap all unused conduit openings and stubups. Do not use caulking compound.

G. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

H. Set conduits as follows:

1. Expanding silicone firestop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
2. Oakum and lead, sealed watertight penetration through outside foundation walls.

I. Cap open ends of conduits until conductors are installed.

J. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18" and maximum length of 36" shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

K. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

L. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

3.6 CONTROL TRANSFORMERS

A. Control transformers shall be field mounted using a plate to mount on the associated junction box or panel using a foot-style mounting. Locations shall be as identified on the Drawings or as determined by field requirements. A phenolic label on each transformer shall identify the power source by breaker panel and circuit. Fusing of the primary and secondary sides and sizing shall be as defined by the NEC. Provide means of local disconnect for transformer to allow removal.

3.7 EQUIPMENT CONNECTIONS

A. Class II field wiring for all non-control device applications shall be installed under this Section of the Specification. This includes equipment such as VFDs, chillers, boilers, packaged air handling equipment, etc.

3.8 HVAC SYSTEM TIMECLOCK

A. Locate timeclock inside the building shown on the drawings or coordinate with the owner. Wire timeclock to associated mechanical equipment as outlined on the drawings.

B. Program the timeclock based on the occupancy schedule for the building as coordinate with the building owner.

3.9 DOMESTIC WATER SUB-METER

A. The sensors and transmitters shall be installed in accordance with the manufacturer's installation requirements. All inline meters shall be installed with isolation valves on both sides. A by-pass is not required. The contractor shall connect all outputs from the transmitters and meter to the QuickServer per the requirements of these specifications. The contractor shall provide all necessary transformers to provide power for all transmitters and meters.

3.10 GAS SUB-METER

A. The sensors and transmitters shall be installed in accordance with the manufacturer's installation requirements. The contractor shall connect all outputs from the transmitters and meter to the QuickServer per the requirements of these specifications. The contractor shall provide all necessary transformers to provide power for all transmitters and meters.

3.11 MEASUREMENT AND VERIFICATION SYSTEM

A. Install the QuickServer in a NEMA 1 electrical enclosure with hinged door inside main electrical room near main electrical meter. Connect power supply and Ethernet port.

B. Connect the gas and water meters to the Flow Display. Provide 24VAC power to the display and RS485 network connection between the Flow Display and the QuickServer.

END OF SECTION 230900

SECTION 233000 - AIR TEMPERING SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Provide all products, labor and services necessary to construct and demonstrate proper functionality of the HVAC and exhaust systems indicated on the drawings and specified herein.

B. Conform with applicable provisions of the General Conditions, the Supplemental General Conditions and General Requirements.

C. See Sections 23 0500, 23 0549, 23 0593, 23 0700, and 23 0900 for additional requirements.

D. Comply with the Equipment General Requirements in Spec Section 23 0500.

1.2 SCOPE

A. Install control dampers supplied under Section 23 0900. Adjust dampers for smooth operation.

B. Equipment provided by others: Provide ductwork to serve equipment provided by others, including fume hoods, etc, where that equipment requires ducted supply or exhaust.

1.3 SUBMITTALS

A. Submit the following for review and approval:

1. All equipment shown on the equipment schedule and elsewhere on the drawings. Submit evidence or certification that equipment complies with ASHRAE Std. 90.1.
2. Ductwork construction standards, sheet metal, plenums, ductwork accessories, etc.
3. Flues and vents: Materials of construction and accessories. For vents with horizontal offsets or expansion joints, submit layout for review.
4. Dampers for fire and smoke control: For each type of damper proposed, submit manufacturer's literature demonstrating compliance with all aspects of the specifications and drawings. Submit manufacturer's installation instructions.
5. Air Filters and Filter Gauges
6. Grilles, Registers & Diffusers: Configuration, materials of construction, finish, mounting details, and performance data including throw, static-pressure drop, and noise ratings. Submit for type only, but supplier shall check and verify that the indicated diffuser type and sizing are appropriate for each area. Advise of any concerns in any areas.
7. Terminal Units:

    a. Submit the following for each type of unit: Unit construction, materials, and wiring diagrams.
    b. Submit the following for each size unit: Dimensional data, recommended flow ranges, and performance data (pressure drop and sound data) at maximum flow.

c. Submit a schedule showing the following for each terminal unit indicated on the drawings: Tag number, max & min CFM, size, pressure drop, and heating system performance.

8. Layouts of systems covered by this section of the specifications. Layouts shall be at a scale appropriate for the areas shown. Include large scale sections as appropriate.

1.4 QUALITY ASSURANCE

A. Comply with the following codes & standards:

1. UMC 2006 Chapter 6 – Duct Systems
2. UMC 2006 Standard 6-2, Standard for Metal Ducts
3. SMACNA 1995 HVAC Duct Construction Standards – Metal and Flexible, including Addendum 1 dated 11/1997
4. SMACNA Round Industrial Duct Construction Standards – 1999
5. SMACNA Rectangular Industrial Duct Construction Standards – 2004
6. NFPA-90A-2002 - Standard for the Installation of Air-Conditioning and Ventilating Systems

B. Component Characteristics

1. All components within ducts and plenums shall be non-combustible or shall have a flame spread less than 25 and smoke developed less than 50 when tested as a composite product per NFPA 255, ASTM E84, or UL 723, except where specifically permitted by the UMC and noted in the drawings or specs.

1.5 SOUND LEVELS

A. Sound levels attributable to mechanical equipment are designed to result in sound levels of NC 40 for offices, conference rooms, and NC 35 for library, classrooms, etc., measured within the rooms. Mechanical equipment that has been substituted for the specified equipment shall perform within the specified equipment sound limitations, or will be replaced or adjusted as required. Sound levels attributable to duct vibration that result in noticeable noise or vibration to duct hangers, lighting fixtures, ceiling tees or diffusers shall be re-supported or adjusted until the disturbing noise is brought within acceptable limits.

1.6 DIMENSIONS

A. Compare all drawings and verify all dimensions both on the drawings and in the field before laying-out, cutting, and fabricating the work.

B. Refer to Section 23 0500, Common Work Requirements for HVAC, for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 DUCTWORK AND PLENUMS

A. Materials: Construct all ducts, casings, plenums etc. from galvanized steel sheets except as indicated. Sheets shall be free of blisters, slivers, pits, and imperfectly galvanized spots. Reinforcing angles and bars, and duct support materials shall be same material as ductwork if exposed to the air stream, or galvanized steel if not exposed to the air stream.

1. Galvanized Steel: Per ASTM A653/A653-03 Standard Specification for Steel Sheet, Zinc-Coat (Galvanized) or Zinc-Iron Alloy-Coat (Galvanized) by the Hot Dip Process, with minimum 1.25oz/sf zinc.
2. Aluminum: Alloy 3003-H14
3. Stainless Steel: 340SS, provide No. 2B finish in exposed areas
4. Fiberglass Ductwork (Ductboard): Use only where specifically noted. Minimum 1-inch thick, 3 lb. density rigid fiberglass ductboard with glass fiber reinforced vapor barrier, UL Class 1, labeled on each board per UMC-06 Standard 6-5.

    a. Properties:

        1) Thermal conductivity for 1-inch thickness shall not exceed 0.22 Btuh/SF-F at 75 deg F
        2) Noise reduction coefficient of 0.80 on Mounting No. 6.

    b. Tape: 3-inch "Hardcast" mineral impregnated woven fiber tape with an actuator/adhesive applied in accordance with the manufacturer's directions, or thermlok heat sensitive tapes. Pressure sensitive tapes will not be accepted.
    c. Owens-Corning Fiberglass, Johns Manville, Certain-Teed or equivalent. Flexural rigidity (E.I.) average shall not be less than 475.

B. Flexible Ducts: Factory fabricated, listed as a Class 1 Air Duct per UL 181 with aluminum foil interior liner, corrosion resistant helix mechanically locked to fabric to ensure dimensional stability, helix separated from air stream, 1.5-inch fiberglass insulation with conductance not to exceed 0.23 Btuh-in/Hr-SF-F, and fire retardant outer vapor barrier. Ducts shall be rated at 12-inch positive pressure, 5-inch negative pressure, 0.1 perm per ASTM E96, and -20 to +250ºF. Flexmaster Type 3, Technaflex 57K, OAE.

C. Ductwork Accessories

1. Sealers: Water based, for use on galvanized steel and with the other materials specified herein, suitable for use at -20 to +200ºF and duct pressures to 10 inches wg, dry to the touch within 12 hours, sufficiently flexible to pass a 0.25-inch mandrel test, listed per UL-181A & 181B, and suitable for storage and application at 40–110ºF. Approved Manufacturers: Carlisle Coatings & Waterproofing “Hardcast,” Foster, RCD, AM Conservation Group, OAE.
2. Tapes: 4” woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal. Water, mold, and mildew resistant for indoor and outdoor service. Sealant shall be modified styrene acrylic.

2.2 SHEET METAL ACCESSORIES

A. Dampers: Factory fabricated, suitable for use with air at -20 to +240°F, galvanized steel housing and blades except as noted, rated for indicated pressures in either direction and performance rated per AMCA-500.

1. Shafts: Square or hexagonal steel, 3/8-inch or 1/2-inch, continuous through damper, mechanically fastened to damper blade, and extending through frame as required for actuator or standoff bracket and locking quadrant as required by table below.
2. Bearings: Provide for each side of each shaft, molded synthetic or stainless steel sleeve type.
3. Multi-blade dampers: Except as indicated, provide parallel-blade for 2-position applications and opposed blade for modulating applications. Provide jackshafts as required to drive large dampers.
4. Air pressure drop shall not exceed:

   a. Dampers rated at 1500 FPM: 1" in wg at 1500 FPM
   b. Dampers rated at 4000 FPM: 4" in. wg at 4000 FPM

5. The dampers described in this section are assigned Type Numbers D1 through D23. The following table summarizes key characteristics of each type of damper. Drawings and Part 3 – Execution, indicate which type of damper to use in each application.

Type	Shape	Blade	Max Size (inches)	Multiple Sections	Rated Velocity (FPM)	Rated Shutoff Press. (in. wg)	Seals	Leakage (CFM/SF @ 1 in. DP)	Notes	Ruskin Model
D1	Rect	Flat	36 x 12	No	1500	2.5	No	--	1	MD15
D1	Rect	3V	48 x 48	No	1500	2.5	No	--	1	MD15
D2	Rect	Flat	36 x 12	No	1500	2	No	--	1	MD25
D3	Rect	3V	48 x 48	Yes	1500	2	No	80	1	MD35
D4	Rect	3V	48 x 72	Yes	1500	2.5	No	40		CD35
D5	Rect	3V	48 x 72	Yes	1500	2.5	Yes	4		CD36
D6	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2	2	CD50
D7	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2		CD60
D20	Round	Flat	20	No	1500	2	No	40	1	MDSR25
D21	Round	Double	40	No	4000	10	Yes	4		CDR25
D22	Round	Double	24	No	4000	6	Yes	6		CDSR25
D23	Oval	Double	72 x 24	No	4000	10	Yes	4		CDO25

Note 1: Provide locking hand quadrant and 2-inch standoff bracket
Note 2: Aluminum Construction

B. Flexible Connectors: Except as noted flexible connectors shall be heavy fiberglass cloth; coated to be air tight, water tight, fire retardant; suitable for temperatures of -20 to +200° F; rated for 10 in. wg positive or negative; with tensile strength minimum 450 lb/inch in the warp and 340 lb/inch in the filling. Provide flexible connectors in 3-3-3 configuration, with 3-inch galvanized steel strip along each edge and 3-inches of flexible fabric in the center.

1. Standard Applications: Flame spread 20, smoke developed 40, Ventfabrics Ventglas OAE
2. Applications Exposed to Sun and Weather: Double coated with du Pont Hyphalon, Ventfabrics Ventlon OAE.
3. Applications from 200 – 500° F: Tensile Strength 285 lb/inch in the wrap and 185 lb/inch in the filling. Ventfabrics Ventsil OAE
4. Corrosive Applications: Teflon coated, Ventfabrics Ventel OAE.

C. Duct and Plenum Access Doors: Galvanized steel, gasketed. Size as required to properly inspect and service components located within the ductwork. Ruskin, Acudoor, Ductmate, OAE.

1. Rectangular ducts up to 2-inch positive or negative SP: Minimum 22 gauge frame and door thru 12-inch size, 20 gauge door for larger sizes, double gasketed (between door and frame, and between frame and duct) with cam locks, either hinged or removable. Ruskin ADH22, ADC22, ADHW22, or ADCW22, Ventfabrics, OAE
2. Round or Rectangular Ducts to 12-inch Positive Pressure: Removable oval sandwich style with gasketed inner door, insulated outer door, and large hand knobs. Ruskin ADR and ADF.
3. Ducts to 12-inch Negative Pressure: Ruskin ADHP-3.
4. Plenum Access Doors: Factory fabricated frame and door rated to 4-inch positive or 8-inch negative pressure. Provide mill finish and neoprene seals to limit leakage to less than 0.1 CFM/inch perimeter with door closed. Doors shall open against air pressure.

    a. Frame: Extruded aluminum with 1.5-inch flange and mitered corners
    b. Door: Extruded aluminum mitered frame, double wall 24-gauge galvanized steel panel with minimum R-5 insulation isolated from the air stream, full-length piano hinge and two heavy-duty latches similar to Ventlok 310.
    c. Approved Manufacturers: Ruskin GPAD or approved equal.

D. Turning Vanes:

1. Single wall: Per SMACNA HVAC Duct Construction Standards Figure 2-3 & 2-4.
2. Double wall: Airfoil shape with smoothly rounded entry nose and extended trailing edge, minimum 2” x 3” vane crossection, hot dipped galvanized steel, 26-gauge vanes, 24-gauge runner, each vane double pinned to each runner, field adjustable to required elbow aspect ratio. Performance shall not exceed the following for a 24 x 24 elbow at 2000 FPM average: Air pressure drop 0.105 in. wg; aound generated 54 dB re 10^-12 watts. Aero/Dyne Co. Model HEP, Airsan, Elgen, or equivalent.

E. Roof Curbs and Equipment Support Rails: Factory fabricated, minimum 14-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction.

1. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, OAE.
2. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck OAE

F. Louvers: 4-inch extruded 6063-T5 aluminum alloy frame and blades with flange, mill finish, and 1/2-inch galvanized steel bird screen.

1. Structural: Suitable for 100 MPH wind loading when supported along the perimeter only for sizes up to 90" x 120". Intermediate mullions and supports if provided as part of louver, shall not be visible from the exterior.
2. Air Pressure Drop: Less than 0.20 in wg at 470 FPM over gross area, intake or exhaust per AMCA 500 based on 48 x 48 test sample.
3. Moisture Penetration: Less than 0.01 oz/sf over 15 minute test per AMCA-500 at 470 FPM intake over gross area based on 48 x 48 test sample.
4. Ruskin ELF375D OAE.

G. Acoustic Louvers

1. Ruskin ACL 1245, 12 inches deep, with 45 degree blade angle, 22 percent free area (48" x 48" typical unit with .15 inch w.g. maximum pressure drop, at 4277 cfm air flow). Frame and blade material shall be galvanized steel. Free field noise reduction shall be:

Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Reduction (db)		14	13	15	20	23	22	20
20								

2. Provide bird-screen, steel channel frame, Ruskatherm blanket insulation, and perforated steel interior surface that covers insulation.

H. Thermometers: As specified in Section 23 0505.

I. Barometric Pressure Balance Dampers: Air Balance, Inc. units with adjustable counter weight, aluminum air foil design blades, nylon bearings. Match frame assembly to wall or duct.

FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT

J. General: Factory-built metallic vent system, UL Listed components. Each component shall bear indication of its UL listing.

1. Heat Resistant Paint: Glidden, Metallite OAE.
2. Approved Vent Manufacturers: Metal Fab, Metalbestos, Schebler, Ampco, OAE.

K. Type B Vent: Listed per UL 441 for use with UL Listed Category I (gas or propane fired, negative pressure, non-condensing) appliances to 530° F, round or flat oval as indicated, double wall with aluminum alloy inner wall, galvanized steel outer wall, both walls hemmed to eliminate sharp edges, minimum 1/4-inch air space for sizes 6-inches and smaller and minimum 1/2-inch air space for sizes 7-inches and larger, with guides to maintain air space. Provide UL Listed vent cap. Metal Fab Type M.

1. Barometric Draft Regulator: UL Listed, double acting type.

L. Type III Vent: For use with Category III appliances or other positive pressure, non-condensing appliances including oil-fired or solid-fuel equipment not exceeding 1200° F exhaust temperature. Listed per UL-103 for use with gas, liquid or solid fuels per NFPA-211 which produce gases up to 1400° F continuously and 1800°F intermittently. Double wall with spacers

to maintain alignment, rated for 10-inch clearance to combustibles, 4-inch clearance to noncombustibles, and zero clearance to fire-rated or non-combustible chase.

1. Inner Pipe: Connected with V-bands of same material as inner pipe, and sealed with silicone sealant appropriate for the exhaust gas temperature. Pressure tight to 60 inches water.
2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors.
3. Expansion Joints: Bellows type.
4. Options and Accessories:

    a. Inner Wall: 304 SS.
    b. Outer Wall: Aluminized steel.
    c. 12-year warranty against defects in materials and workmanship

M. Type IV Vent: For use with Category II or Category IV appliances (natural gas or propane-fired, positive or negative pressure, condensing, not exceeding 550^{o} F exhaust temperature). Listed per UL-1738, double wall with 1-inch clearance and spacers to maintain alignment.

1. Inner Pipe: AL2904C superferritic SS manufactured by Allegheny Ludlun, with welded seams, connected with V-bands, and sealed with high temperature silicone sealant. Rated at 6 inches water. Thickness: 0.015-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors. Thickness: 0.018-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
3. Options and Accessories:

    a. Outer Wall: Aluminized steel

4. Metal Fab Type CG

2.3 FILTERS AND FILTER GAUGES

A. See Equipment Schedule.

2.4 GRILLES, REGISTERS AND DIFFUSERS

A. General: Performance rated per ASHRAE Std 70, *Method of Testing for Rating the Performance of Air Outlets and Inlets*, steel with baked white enamel finish except as noted, for installation on a fixed surface or a lay-in T-bar ceiling as indicated on architectural drawings, rigidly constructed, vibration free, with inlet collar of sufficient length to connect inlet ductwork, sized as shown on drawings. Where frames are provided for installation in fixed surfaces, frames shall be approximately 1-1/8” wide. Sound performance rated per ADC and based on room absorption of 10dBre10^{-12} Watts and one diffuser.

1. Approved Manufacturers: Price, Krueger, Titus, Anemostat, OAE

B. Types as follows. See also the Grille and Diffuser Schedule on drawings.

1. Square Ceiling Diffusers: Louvered type, 4-way pattern, 1-piece smooth aerodynamic surfaces with no corner joints, three louvers for 12-inch sizes, four louvers for 24-inch sizes, removable louver assembly, round neck, to provide stable, horizontal air flow without dumping down to 75 FPM inlet velocity for ceiling applications, and down to 20% of maximum air flow for non-ceiling applications. Price –Model SCD.
2. Sidewall Supply Registers: Double deflection with ganged horizontal front bars, individually adjustable vertical rear bars, 3/4" bar spacing and surface mounting frame. Price 520.
3. Sidewall Return, Exhaust and Transfer Grilles: Fixed horizontal bars on 3/4" centers set at 30-45 degrees, surface mounting frame. Price-Model 530.
4. Ceiling or Sidewall Linear Supply Diffusers: Extruded aluminum with baked white enamel finish, frame suitable for lay-in or surface mounting as per the architectural drawings, all aluminum construction, flat black interior surfaces, air flow deflection vanes to provide each slot with individually and fully adjustable 180^{o} air pattern from horizontal to vertical or in between, self-aligning devices to ensure proper alignment where multiple sections are required, and corner pieces as necessary for a continuous appearance. Provide galvanized steel side inlet plenum matched to diffuser, with plenum extension if necessary to match adjacent construction. Performance data is based on 3/4-inch slots unless otherwise indicated. See plans for required air flow, diffuser length, and number of slots. Price Model SDS with SDA or SDB plenum, Krueger Model 1910, or equivalent.
5. Ceiling Return Grilles: Fixed ½” aluminum grid core with frame to match ceiling type. Price- Model 80 or equal.
6. Ceiling Exhaust Grilles: Fixed ½” aluminum grid core with frame to match ceiling and adjustable steel damper. Price-Model 80D or equal.

2.5 FANS

A. General

1. Construction

a. Factory fabricated fan, motor, drive and accessories, UL listed , with air flow rated per AMCA 211 and sound rated per AMCA.
b. Fan wheel: Statically & dynamically balanced, with shaft sized so first critical speed is minimum 25% above maximum operating speed.
c. Motor and Drive: Premium efficiency ODP motor per Spec Section 23 0500, direct drive or belt driven as indicated in schedule on drawings, bearings with 100,000 hr L-10 life.
    1) Variable Speed Applications: Provide Class F insulation.
d. Belt Drives: Adjustable pitch sheave up to 5 Hp, fixed pitch above this Hp, cast and machined pulleys with all components sized for 150% of motor Hp.
e. Dampers:
f. Accessories:
    1) Roof Curb: Minimum 24-inch galvanized steel, fiberglass insulated, with wood nailer, damper tray and flange. Provide cant and step if needed for proper seal with roof.

B. Centrifugal Roof Exhaust Fans

1. Leakproof construction.
2. Housing: Spun aluminum construction, reinforced wind band welded to one-piece curb cap with mounting holes on the side and integral spun venturi, spun aluminum motor compartment with readily removable cover and breather tube. All other structural components shall be galvanized steel.
3. Fan wheel: Backward inclined, centrifugal, non-overloading.
4. Motor and Drive: Motor out of the air stream, cooled with ambient air. Motor, drive and fan wheel resiliently mounted on neoprene isolators.
5. Electrical: Disconnect NEMA-1 if protected from the weather, or NEMA-3R if exposed to the weather, wired to motor, with all wiring and components per NEC and either UL Listed or UL recognized.
6. Accessories: Stamped aluminum nameplate, hinge kit to allow tilting fan up to inspect wheel, retaining chains, conduit chase and roof curb.
7. Approved Manufacturers: Greenheck Type, G, GB, CUE or CUBE as indicated. Cook, ACME, OAE.

2.6 PACKAGED OUTDOOR CENTRAL STATION AIR HANDLER UNIT / ROOF TOP UNIT

A. See Specification 23 7413

PART 3 - EXECUTION

3.1 DUCTWORK AND PLENUMS

A. Ductwork

1. Construct ductwork with wall thicknesses and reinforcing per the SMACNA HVAC Duct Construction Standards, Second Edition, 1995, and UMC 2006 Chapter 6,
2. Pressure Classes: Construct ductwork to the following pressure classes:

Duct Element Description	Relative Pressure	Pressure Class
From Outside Air Louver to Filter:	N	1"
From Single Zone AHU to Diffuser	P	2”
From Terminal Unit to Diffuser:	P	1"
From Return Grille to Fan:	N	1"
From Return Fan to Relief Louver:	P	1"
From Exhaust Register to Exhaust Fan:	N	2"

3. Minimum thickness for sheet metal ductwork: 26 gauge.
4. Sealing: Seal ductwork and plenums as follows:

	Seal Class			
	Supply Ducts			
Location	≤2 in. wg	≥2 in wg	Exhaust	Return
Outdoors	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces including RA Plenums	C	B	B	C

Seal Class	Description
A	All transverse joint, longitudinal seams and duct wall penetrations.
B	All transverse joints and longitudinal seams.
C	Transverse joints

a. Apply duct sealer to inside of seams and joints. Do not use pressure sensitive tape as the primary sealant.

5. Clearance to earth: Maintain minimum 4-inch separation between ductwork insulation and earth.
6. Openings in Ductwork: During installation protect the open ends of ducts to prevent debris and dirt from entering.
7. Provide turning vanes in square elbows of low velocity supply and exhaust ductwork.
8. Collars: Where exposed ducts pass through walls, floors, or ceilings, provide a tight-fitting, flanged sheetmetal collar around duct and tight against finished surface to cover opening and present a neat appearance. Lock collar to duct.
9. Cross Breaking: Cross-break low velocity rectangular sheetmetal ducts on all four sides. Cross break sheet metal between standing seams or reinforcing angles. The center of cross break shall be of the required height to assure surfaces being rigid. Do not cross-break high velocity plenum panels.
10. Grilles Registers and Diffusers: Install plumb, affix to general construction as appropriate, make air-tight connection to ductwork, and adjust air flow pattern to achieve appropriate velocities in the occupied zones. Request direction from Engineer if any question exists regarding proper air flow adjustment.
11. Duct Thermometers: Provide thermometers to indicate mixed air, outside air, and supply air of indoor air handling units over 2,500 cfm and where shown on the Drawings.
12. Test Holes: Provide test holes in ducts at locations where testing is required per Section 23 0593 and as requested by the T&B agent. Close test holes with rubber plugs. Reseal all insulated ductwork with the same insulation, jacket and vapor barrier material after T&B is complete.
13. Closure Systems:

    a. Rigid Air Ducts: Comply with UL 181A – Standard for Closure Systems for Use with Rigid Air Ducts and Air Connectors.
    b. Flexible Air Ducts: Comply with UL 181B – Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors.

14. Factory Made Air Ducts: Install in accordance with the terms of their listing and the manufacturer's recommendations.
15. Acoustic Insulation: See Section 23 0700, HVAC Insulation. Fabricate ductwork so the dimensions indicated on the drawings are the clear dimensions for air flow inside the acoustic insulation.
16. Coordination with Building Construction

    a. General: The drawings show the general intended configuration of the ductwork. Provide additional offsets where necessary to coordinate with the building construction or with the work of other disciplines. Transition ductwork as required at no change in contract price. Where this is necessary, submit for review and maintain the indicated flow areas.

b. Ductwork is frequently routed through bar joists and between bar joists. Coordinate duct locations with joist submittals prior to fabrication.

B. Special Applications

1. Moisture Laden Ductwork: Stainless steel with all joints liquid-tight by continuous external welding. Welds shall be free from pits, runs, spatter and other imperfections. Pitch horizontal ductwork downward to intake opening. Where traps occur that collect water, provide a 1/2-inch half coupling welded to the bottom of the duct and pipe to spill over nearest drain. Include a properly sized trap in the drain piping.
2. Fume Hood Ductwork: Stainless steel with seams and joints continuously welded on the exterior. Spiral lock seam is not acceptable.
3. Shower Room Exhaust Ductwork: Aluminum
4. Ducts Handling Corrosive Vapors: Either stainless steel or galvanized steel with internal polyvinyl coating constructed and sealed as noted.
5. Fiberglass Ductwork (Ductboard)

   a. Provide fiberglass ductboard only where specifically indicated on the drawings and in this specification.
   b. Install per UMC-06 Standard 6-05 – Standard for Installation of Factory-Made Air Ducts and SMACNA Standard 1884-2003 – Fibrous Glass Duct Construction Standard.
   c. The drawings indicate required clear inside dimensions for air flow.
   d. Where a duct constructed of ductboard penetrates a wall or floor which requires a fire damper, smoke damper, or fire/smoke damper, install the FD, SMD or FSD in the wall per its listing, make sheet metal connections to the damper if required, and then transition back to ductboard.

6. Exterior Ductwork: Install ductwork as specified herein and insulate per Section 23 0700. Then enclose the exposed top and sides of ductwork with 28 gauge galvanized steel or 26-guage aluminum to protect the insulation. Repair any damage to the insulation jacket. Slope sheet metal enclosure to shed water.

C. Hangers and Supports

1. Securely support ducts per SMACNA and UMC Table 6-7. Provide support at each concentrated load and at each change in direction. Provide supports on each side of rectangular ducts and equipment. Where vertical ducts pass through floors or roofs, support with angles or other steel members attached to minimum two opposite sides of duct. Size supports to rigidly support the ductwork. Provide lateral support.
2. Hangers for terminal units: Minimum four 1" x 1/8" galvanized steel straps or two angle trapeze supports.
3. Horizontal Round Ducts: 30 inches and larger in diameter: Provide 2" x 2" x 1/8" black steel rolled angle ring on 6-ft centers, and support from angle.

3.2 DUCTWORK ACCESSORIES

A. Dampers: Install dampers with shafts horizontal. Locate dampers so that actuators are readily accessible. Verify that dampers operate smoothly.

1. Manual Dampers (Balancing Dampers): Damper Types D1 through D23 are all suitable for use as manual balancing dampers. Provide locking quadrants.
2. Automatic Applications: The following damper types may be used for automatic applications: D4, D5, D6, D7, D21, D22 and D23. Provide damper actuators per Section 23 0900.

B. Flexible Connectors: Provide flexible connectors at locations indicated on the drawings and at the inlet and outlet of each fan directly connected to duct system. Select flexible connectors appropriate for the application. Provide steel spring vibration isolators spanning across flexible connections of isolated fan housings to prevent blow-apart due to horizontal displacement of fan housings.

C. Access Doors: Provide as required for access to all components located within ductwork. Locate to facilitate access to such components. Size as appropriate. In addition to locations specifically called out on the drawings or elsewhere in these specs, provide access doors at the following: FDs, SMDs, FSDs, instrumentation mounted within ductwork, fan bearings.

D. Turning Vanes: Provide turning vanes in square elbows of all supply ducts. Single wall turning vanes may be used in ducts up to 1500 FPM and 24-inch vane length. Provide double wall turning vanes in ducts exceeding either of these criteria.

E. Roof Curbs and Equipment Support Rails: Coordinate the location of roof curbs and rails with the roof structure, ductwork distribution, and other work. Install after roof deck is installed but before roof is insulated. Mount curbs and rails securely to deck per manufacturer's recommendations. Provide counterflashing as required.

3.3 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT

A. General: Install per the drawings and these specifications, manufacturer's instructions, the terms of the vent's UL Listing, the UMC and NFPA-211.

1. Use the same type vent for the entire system from the equipment connection to the termination outside. Provide all fittings, transitions, adapters, supports, storm collars, etc. Install per the venting requirements of the appliance manufacturer. Comply with clearances per UL Listing. Minimize offsets and resistance to flow. System shall develop a positive flow adequate to remove products of combustion to outside. Do not run any portion of the vent system through any supply or return air duct or plenum. Do not connect the vent from any Category I or II (non-positive pressure) appliance with any Category III or IV (positive pressure) appliance. Do not install any manually operated damper at any point in vent system.
2. Properly support the system and make provisions for thermal expansion. Install so as to prevent leakage of flue gases into the building. Provide drain connections where condensate is likely to accumulate, and pipe to spill over floor drain.
3. Provide ventilated thimbles where vents pass through walls, floors and roof. Paint all galvanized or aluminized steel parts exposed to the weather with one coat of corrosion and heat-resistant primer, and one coat of heat resistant paint.
4. Terminate low heat appliances as indicated on the drawings, but not less than:

    a. 3 ft above the highest point where the vent passes the roof.
    b. 2 ft above any portion of a building within a horizontal distance of 10 ft.

c. 3 ft above any forced air inlet located within 10 ft.

B. Type B: If a draft damper is supplied with the appliance for installation in the flue, install it per manufacturer's instructions. If appliance is listed for use with a draft hood but is not supplied with one, provide a properly sized barometric draft regulator immediately in the vent outlet, and install per manufacturer's recommendations. Pitch vent up minimum 1/4-inch per foot. Join sections per manufacturer's recommendations using sheet metal screws or proprietary closure system of a UL Listed venting system. Provide vent cap,

C. Type III and IV: Install per the drawings and these specifications, per manufacturer's instructions, per the terms of the vent's UL listing, and per NFPA-211.

3.4 GRILLES REGISTERS AND DIFFUSERS

A. Install grilles, registers & diffusers (GRDs) square with building construction. Mount sidewall GRDs minimum, 3-inches above floor level. If GRDs have provisions to adjust the direction of air flow, submit a written recommendation regarding the best direction for air flows, obtain written approval from the Owner's Representative, and adjust GRDs accordingly.

B. Verify frame types with architectural RCPs prior to ordering GRDs.

3.5 CLOSEOUT ISSUES

A. Testing and Balancing: Test and balance the complete air tempering system as specified in Section 23 0593. It is anticipated that the TAB effort will identify some system deficiencies. Work in a cooperative manner to identify the cause of these deficiencies. Where deficiencies are due to defects in installation, or workmanship, repair as required and re-test to demonstrate proper performance.

B. Cleaning

1. All ducts, coils, housing, registers, grilles, fans, etc., shall be clean when installed and shall be kept clean until the system is completed. As the various parts of the system are installed, they shall be wiped or blown clean and openings taped dust-tight with heavy paper or cardboard until the system is completed and ready for testing. At that time all covers and protective wrappings shall be removed. Where one has been torn or previously removed, the duct, coil, register, etc., shall be carefully cleaned of any dirt or dust that has entered the opening.

END OF SECTION 233000

SECTION 237413 - PACKAGED OUTDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes high efficiency packaged, outdoor, central-station air-handling unit (roof top unit) with the following components and accessories:

1. Direct-expansion cooling.
2. Gas furnace.
3. Economizer outdoor, Merv 8 filter, and return-air damper section.
   a. Provide two extra / spare sets of Merv 8 Filters per unit.
4. Exhaust fan or barometric relief hood.
5. Supply fan
6. Non Powered Service Receptacle (to be powered separately by division 26)
7. Integral, space temperature controls.
8. 14” tall roof curbs.

1.2 DEFINITIONS

A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data.

E. Warranty.

1.4 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: One Year warranty in which manufacturer/contractor agrees to replace components of RTUs that fail in materials, workmanship or installation within a one year period after owner occupancy.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 15 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Carrier equipment no exceptions.

B. Packaged units (3 to 5 Ton)

1. General

a. The units shall be convertible airflow. The operating range shall be between 105°F and 0°F cooling as standard from the factory for units with microprocessor controls. Cooling performance shall be rated in accordance with ARI testing procedures. All units shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be cULus listed and labeled, classified in accordance for Central Cooling Air Conditioners.

2. Casing

a. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 672 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit. Service panels shall have lifting handles and be removed and reinstalled by removing two fasteners while providing a water and air tight seal. All exposed vertical panels and top covers in the indoor air section shall be insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material. The base of the unit shall be insulated with 1/8 inch, foil-faced, closed-cell insulation. All insulation edges shall be either captured or sealed. The unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 1 1/8 inch high downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting, with forklift capabilities on three sides of the unit.

3. Unit Top

a. The top cover shall be one piece construction or, where seams exist, it shall be double-hemmed and gasket-sealed. The ribbed top adds extra strength and enhances water removal from unit top.

4. Two-Inch Pleated Filters

    a. 2" pleated Merv 8 filters. Provide two extra spare sets of Merv 8 Filters with each unit.

5. Compressors

    a. All units shall have direct-drive and hermetic type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors.
    b. Crankcase heaters shall be included.
    c. Two-stage compressor for light load cooling conditions.

6. Indoor Fan

    a. The following units shall be equipped with (1-phase or high efficiency 3-phase) shall have multispeed, direct drive motors. All motors shall be thermally protected.
    b. All motors shall be thermally protected. All indoor fan motors meet the U.S. Energy Policy Act of 1992 (EPACT).

7. Outdoor Fans

    a. The outdoor fan shall be direct-drive, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motor shall be permanently lubricated and shall have built-in thermal overload protection.

8. Evaporator and Condenser Coils

    a. Internally finned, 5/16" copper tubes mechanically bonded to a configured aluminum plate fin evaporator coil. Microchannel type condenser coil. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 600 psig. The assembled unit shall be leak tested to 465 psig.

9. IAQ removable, reversible, double-sloped condensate drain pan with through the base condensate drain.

10. Tool-less Hail Guards

    a. Tool-less, hail protection coil guards for condenser coil protection.

11. Controls

a. Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device.

12. Microprocessor controls provide for all 24V control functions. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point, and provides better building comfort. A centralized microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.

13. Clogged Filter/Fan Failure Switch
14. A dedicated differential pressure switch is available to achieve active fan failure indication and/or clogged filter indication. These indications will be registered with either a zone sensor with status indication lights or an Integrated Comfort™ System. This option is available for microprocessor controlled units.
15. Discharge Air Temperature Sensing
16. This option provides true discharge air temperature sensing in heating models. This sensor is a status indicator readable throughTracer™ orTracker™.This option is available for microprocessor controlled units.
17. High Pressure Control

    a. All units shall include High Pressure Cutout.

18. Phase monitor

    a. Phase monitor shall provide 100% protection for motors and compressors against problems caused by phase loss, phase imbalance, and phase reversal. Phase monitor is equipped with an LED that provides an ON or FAULT indicator. There are no field adjustments. The module will automatically reset from a fault condition.

19. Refrigerant Circuits

    a. Each refrigerant circuit offer thermal expansion valve as standard. Service pressure ports, and refrigerant line filter driers are factory-installed as standard. An area shall be provided for replacement suction line driers.

20. Gas Heating Section

    a. The heating section shall have a progressive tubular heat exchanger design using stainless steel burners and corrosion resistant steel throughout. An induced draft combustion blower shall be used to pull the combustion products through the firing tubes. The heater shall use a direct spark ignition (DSI) system. On initial call for heat, the combustion blower shall purge the heat exchanger for 20 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat/zone sensor. Units shall be suitable for use with natural gas.

21. Unpowered Convenience Outlet

    a. GFCI, 120v/15amp, 2 plug, convenience outlet.

22. Economizer - downflow or horizontal

    a. The assembly includes fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug, spring return actuator and fixed dry bulb control. The barometric relief shall provide a pressure operated damper that shall be gravity closing and shall prohibit entrance of outside air during the equipment off cycle.

23. Through the Base Electrical Access

    a. An electrical service entrance shall be provided allowing electrical access for both control and main power connections inside the curb and through the base of the unit. Option will allow for field installation of liquid-tight conduit and an external field-installed disconnect switch.
    b. Through the Base Electrical with Disconnect Switch
    c. This 3-pole, molded case, disconnect switch with provisions for through the base electrical connections. The disconnect switch will be installed in the unit in a water tight enclosure with access through a swinging door. Wiring will be provided from the switch to the unit high voltage terminal block. The switch will be UL/CSA agency recognized.
    d. Note: The disconnect switch will be sized per NEC and UL guidelines but will not be used in place of unit overcurrent protection.

24. Roof Curb

    a. The roof curb shall be designed to mate with the unit's downflow or horizontal supply and return and provide support and a water tight installation when installed properly. The roof curb design shall allow field fabricated rectangular supply/return ductwork to be connected directly to the curb. Curb design shall comply with NRCA requirements. Curb shall be shipped knocked down for field assembly and shall include wood nailer strips.

C. Packaged Units (6 to 20 Ton)

1. General

    a. The units shall be dedicated downflow or horizontal airflow. The operating range shall be between 105°F and 0°F in cooling as standard from the factory for all units. Cooling performance shall be rated in accordance with AHRI testing procedures. All units shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation and control sequence, before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be UL listed and labeled, classified in accordance to UL 1995/C 22.2, 236-05 3rd Edition.

2. Casing

    a. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 672 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit. In order to ensure a water and air tight seal, service panels shall have lifting handles and no more than three screws to remove. All exposed vertical panels and top covers in the indoor air section shall be insulated with a 1/2 inch, 1 pound density foil-faced, fire-resistant, permanent, odorless, glass fiber material. The base of the downflow unit shall be insulated with 1/2 inch, 1 pound density foil-faced, closed-cell material. The downflow unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 11/8 inch high supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting.

3. Unit Top

    a. The top cover shall be one piece, or where seams exist, double hemmed and gasket sealed to prevent water leakage.

4. Filters

    a. Two inch pleated MERV 8 filters. Provide two extra spare sets of Merv 8 filters per unit.

5. Compressors

    a. All units shall have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of nameplate voltage. Internal overloads shall be provided with the scroll compressors. All models shall have crankcase heaters, phase monitors and low and high pressure control as standard.

6. Crankcase Heaters

    a. These band heaters provide improved compressor reliability by warming the oil to prevent migration during off-cycles or low ambient conditions.

7. Refrigerant Circuits

    a. Each refrigerant circuit shall have independent fixed orifice or thermostatic expansion devices, service pressure ports, and refrigerant line filter driers factory installed as standard. An area shall be provided for replacement suction line driers.

8. Evaporator and Condenser Coils

9. Microchannel coils will be burst tested by the manufacturer. Internally finned, 5/16" copper tubes mechanically bonded to a configured aluminum plate fin shall be standard for evaporator coils. Microchannel condenser coils shall be standard on all units. Coils shall be leak tested to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 225 psig and pressure tested to 450 psig. Sloped condensate drain pans are standard.

10. Gas Heating Section

11. The heating section shall have a drum and tube heat exchanger design using corrosion resistant steel components. A forced combustion blower shall supply premixed fuel to a single burner ignited by a pilotless hot surface ignition system. In order to provide reliable operation, a negative pressure gas valve shall be used on standard furnaces and a pressure switch on furnaces with modulating heat that requires blower operation to initiate gas flow. On an initial call for heat, the combustion blower shall purge the heat exchanger 45 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat. Units shall be suitable for use with natural gas or propane (field installed kit) and shall also comply with California requirements for low NOx emissions. The 12½- 25 tons shall have two stage heating.

12. Outdoor Fans

    a. The outdoor fan shall be direct-drive, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motor(s) shall be permanently lubricated and shall have built-in thermal overload protection.

13. Indoor Fan

    a. Units above shall have belt driven, FC centrifugal fans with adjustable motor sheaves. Units with standard motors shall have an adjustable idler-arm assembly for quick-adjustment of fan belts and motor sheaves. All motors shall be thermally protected. Oversized motors shall be available for high static application. All indoor fan motors meet the U.S. Energy Policy Act of 1992 (EPACT).

14. Controls

    a. Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device.
    b. Microprocessor controls provide for all 24V control functions. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point, and provides better building comfort. A centralized microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.

c. Discharge Air Temperature Sensing

i. This option provides true discharge air temperature sensing in heating models. This sensor is a status indicator readable throughTracer™ orTracker™.This option is available for microprocessor controlled units.

d. High Pressure Cutout
e. This option is offered for units that do not have High Pressure cutout as standard.

15. Economizer - downflow or horizontal

a. The assembly includes fully modulating 0-100 percent motor and dampers, barometric relief, minimum position setting, preset linkage, wiring harness with plug, fixed dry bulb and spring return actuator. The barometric relief damper shall be standard with the economizer and shall provide a pressure operated damper that shall be gravity closing and shall prohibit entrance of outside air during the equipment "off" cycle. Solid state enthalpy and differential enthalpy control shall be field-installed.

16. Tool-less Hail Guards

a. Tool-less, hail protection coil guards for condenser coil protection.

17. Through the Base Electrical with Disconnect Switch

a. Three-pole, molded case, disconnect switch with provisions for through the base electrical connections are available. The disconnect switch will be installed in the unit in a water tight RT-PRC028-EN 121 enclosure with access through a swinging door. Factory wiring will be provided from the switch to the unit high voltage terminal block. The switch will be UL/CSA agency recognized.
b. Note: The disconnect switch will be sized per NEC and UL guidelines but will not be used in place of unit overcurrent protection.

18. Two-Inch Pleated Filters

a. Two inch pleated media filters- Merv 8. Provided two extra spare sets of Merv 8 Filters per unit.

19. Unpowered Convenience Outlet

a. This option is a GFCI, 120v/15amp, 2 plug, convenience outlet, unpowered.

20. Roof Curb

a. The roof curb shall be designed to mate with the unit and provide support and a water tight installation when installed properly. The roof curb design shall allow field-fabricated rectangular supply/return ductwork to be connected directly to the curb. Curb design shall comply with NRCA requirements. Curb shall be shipped knocked down for field assembly and shall include wood nailer strips.

2.2 CONTROLS

A. RTU Controls:

1. Factory wired and tested with all necessary safety controls and all controls for fully automatic operation per the sequence of operations on the drawings. Each unit shall be provided with a field installed thermostat as specified in section 23 0900. See controls drawings for the intended sequence of control.

2.3 CAPACITIES AND CHARACTERISTICS

A. Supply and exhaust fans: See Equipment Schedule.

B. Heating and cooling: See Equipment Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Install condensate drain, minimum connection size, with trap and indirect connection. See Plumbing drawings.

D. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Division 23 Section "Facility Natural-Gas Piping" Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

E. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section.
3. Install return-air duct continuously through roof structure.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.3 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 237413

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions, and Division 1 Specification Sections apply to all Sections of Division 26.

B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 26 and form a part of the contract.

C. Division 2, Site Work for Trenching, Backfilling and Compaction requirements.

D. Division 1, Coordination for additional requirements.

E. Division 1, Cutting and Patching for additional requirements.

F. Division 1, Submittals for additional requirements.

G. Division 5, Metal Fabrication for additional requirements.

H. Division 7, Firestopping for additional requirements.

I. Division 7, Joint Sealants for additional requirements.

J. Division 9, Painting for additional requirements

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals
2. Coordination Drawings
3. Record Documents
4. Maintenance Manuals
5. Rough-Ins
6. Electrical Installations
7. Cutting and Patching

1.3 ELECTRICAL DIVISION INDEX

Section 26 0500	Common Work Results for Electrical
Section 26 0502	Demolition for Electrical Systems
Section 26 0519	Low Voltage Electrical Power Conductors and Cables
Section 26 0526	Grounding and Bonding for Electrical Systems
Section 26 0529	Hangers and Supports for Electrical Systems
Section 26 0533	Raceway and Boxes for Electrical Systems
Section 26 0543	Underground Ducts and Raceways for Electrical Systems
Section 26 0550	Installation Coordination
Section 26 0553	Identification for Electrical Systems
Section 26 0573	Overcurrent Protective Device Coordination Study
Section 26 0574	Arc-Flash Study
Section 26 0800	Electrical Facility Startup/Commissioning
Section 26 0880	Electrical Acceptance Testing
Section 26 0913	Lighting Control Equipment
Section 26 0923	Digital Occupancy and Daylight Management Control System
Section 26 2213	Low Voltage Distribution Transformers
Section 26 2413	Switchboards
Section 26 2416	Panelboards
Section 26 2726	Wiring Devices
Section 26 2813	Fuses
Section 26 2816	Enclosed Switches and Circuit Breakers
Section 26 2820	Ground Fault Protection
Section 26 2913	Enclosed Controllers
Section 26 4313	Surge Protection Devices for Low Voltage Electrical Power Circuits
Section 26 5618	Interior LED Luminaires
Section 26 5619	LED Exterior Lighting

1.4 CODES AND PERMITS

A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition; the International Building Code, Latest Edition as adopted and interpreted by the State of New Mexico, local municipality (if applicable), and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Secure and pay for all permits necessary for performance of the work. Coordinate all work to be supplied and/or performed by the utility company. Such work may include, but is not limited to:

1. Line extensions and relocations
2. Addition or removal of utility poles and guy anchors
3. Establishment or modification of easements and right-of-way agreements
4. Trenching and backfill
5. Underground conductors and ductbanks

6. Switchgear
7. Transformers
8. Transclosures
9. Metering enclosures and sockets
10. Inspections
11. Connections
12. Temporary power services (to be fully paid by Contractor)

C. The following lists applicable codes and standards that, as a minimum, shall be followed.

Applicable county and state electrical codes, laws and ordinances.
National Electrical Manufacturer's Association Standards
National Electrical Code
National Electrical Safety Code
Underwriters Laboratories, Inc. Standards
American National Standards Institute
American Society for Testing Materials Standards
Standards and requirements of local utility companies
National Fire Protection Association Standards
Institute of Electrical and Electronics Engineers Standards
Insulated Cable Engineers Association
Occupational Safety and Health Act
Uniform Fire Code
Americans with Disabilities Act
Commercial and Industrial Insulation Standards (MICA)

1.5 RECORD DRAWINGS

A. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Use red color to indicate additions or corrections to prints, green color to indicate deletions, and yellow color to indicate items were installed as shown. Keep record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect/Engineer during the construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set. Transmit drawings to the Architect/Engineer at the conclusion of the project for delivery to the Owner's Representative.

B. Prepare record documents in accordance with the requirements in Division 1, Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.6 QUALIFICATIONS

A. Refer to Division 26 sections for installation and testing qualifications.

1.7 SUBSTITUTIONS

A. Refer to the requirements for substitutions in Division 01.

B. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical panels, starters, gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls, which shall conform to the manufacturer's recommendations and these specifications. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.

1.8 PRIOR APPROVAL

A. For all other categories of electrical equipment that are not listed in the preceding paragraph, refer to the requirements for prior approval in Division 01.

B. Requests for proposed substitutions shall be accompanied with the following:

1. Catalog numbers
2. Luminaire Technical data. Including mounting in the appropriate ceiling types.
3. Actual equipment components and options shall be highlighted and any discrepancies with the specified equipment noted. Refer to Division 01 for other requirements related to prior approval submittals.
4. Foot-Candle calculations indicating that the substitution meets the designed foot-candle levels for this project. Each room where the luminaire to be substituted will require these calculations.

1.9 HAZARDOUS CONDITIONS

A. Refer to Division 01 requirements related to the treatment of parts or items that are potentially hazardous to building occupants, maintenance and operation personnel, or to the public.

1.10 DEFINITIONS

A. Definitions of terms will be found in the National Electrical Code.

B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.

C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.

D. "Provide" means furnish, install, connect and test unless otherwise noted.

1.11 SUBMITTALS

A. See Division 1 for all submission requirements.

1.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1, Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.13 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1, Section "PROJECT COORDINATION", to a scale of 1/4" = 1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

    a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    b. Equipment connections and support details
    c. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

1.14 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.15 DRAWINGS AND SPECIFICATIONS

A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.

B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.

C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Architect.

D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.

E. The Architect shall interpret the drawings and the specifications. The Architect's interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.

F. In the case of conflicts not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.

G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.16 SIMILAR MATERIALS

A. All items of a similar type shall be products of the same manufacturer.

B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.

C. Examples of similar equipment types include but are not limited to:

1. Power Circuit Breakers
2. Enclosed Case Circuit Breakers
3. Batteries
4. TVSS
5. Motor Starters
6. Transformers
7. Panelboards
8. Disconnects
9. Fuses

1.17 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.18 GUARANTEE-WARRANTY

A. See Division 1 for warranties for more information.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

> "The Contractor guarantees that this installation is free from ALL defects. He agrees to replace or repair any part of the installation which may fail within a period of one (1) year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date to be determined in writing by means of issuing a 'Certificate of Substantial Completion', AIA Form G704."

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of electrical equipment furnished and installed under Division 26 shall be provided with a full one (1) year parts and labor warranty.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 5,400 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 EQUIPMENT REQUIREMENTS

A. The electrical requirements for equipment specified or indicated on the drawings are based on information available at the time of design. If equipment furnished for installation has electrical requirements other than those indicated on the electrical drawings, make all adjustments to wire and conduit size, controls, over current protection and installation as required to accommodate the equipment supplied. Delineate all adjustments to the drawings reflecting the electrical system in a submittal to the Contract Administrator immediately upon knowledge of the required adjustment.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons, therefore, shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval. All changes shall be marked on record drawings.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 26 with the associated architectural, structural, and mechanical work than is normally necessary for a more typical facility.

E. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

3.3 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with all other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Install access panel or doors where units are concealed behind finished surfaces.
12. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

3.4 FIELD MEASUREMENTS

A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall report any work which must be corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.5 EQUIPMENT SUPPORT

A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.6 PAINTING

A. All finish painting of electrical systems and equipment will be under "Painting," unless equipment is hereinafter specified to be painted.

B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Architect/Engineer.

3.7 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the electrical work to the building structure to prevent damage of equipment and systems due to seismic activity.

B. See Section Division 1 for requirements for seismic supporting of electrical equipment and systems.

3.8 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Architect/Engineer.

C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the

Architect/Engineer prior to such storage.

D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect/Engineer.

3.9 EXCAVATION

A. Provide all excavation, trenching and backfilling required.

B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer’s printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-

resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.13 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.14 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1, Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

    a. Remove and replace defective Work.
    b. Remove and replace Work not conforming to requirements of the Contract Documents.
    c. Remove samples of installed Work as specified for testing.
    d. Install equipment and materials in existing structures.
    e. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. During cutting and patching operations, protect adjacent installations.
6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.15 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Architect/Engineer who shall make such compromises as he deems necessary and desirable.

3.16 CONCRETE BASES AND HOUSEKEEPING PADS

A. Install concrete bases and housekeeping pads under all freestanding electrical equipment unless otherwise noted.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all anchor bolts, etc. Coordinate weight of concrete bases and housekeeping pads with the structural engineer.

C. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with Carborundum block after stripping forms. Tops shall be level. Provide dowel rods or other required material in floor for lateral stability and anchorage.

3.17 TESTS

A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect/Engineer one week in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.18 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish the complete operating and maintenance instructions covering all units of electrical equipment herein specified together with parts lists. Furnish four (4) copies of all the literature; each shall be suitably bound in loose leaf book form.

B. Operating and maintenance manuals as required herein shall be submitted for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the electrical systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

D. The Contractor shall video tape the instruction and training sessions using a VHS camcorder, and at the completion and acceptance (by Owner and Architect) of the training sessions, the Contractor shall submit (2) copies of the video tape.

3.19 CERTIFICATIONS

A. Before receiving final payment, certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Architect/Engineer including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.20 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Architect/Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Architect/Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Architect/Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 260500

DIVISION 26 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.

PROJECT:_____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page:_____ Paragraph/Line:_____ Specified Item:_____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? ☐ YES ☐ NO

   If YES, explain:_____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

   Specified Item Proposed Substitution

   _____ _____

   _____ _____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades? _____

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐

   If YES, explain: _____ _____

7. Will substitution affect progress schedule? YES ☐ NO ☐

   If YES, explain: _____ _____

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐

   If YES, explain: _____ _____

9. Is substitution identical in appearance and function to specialized product? YES ☐ NO ☐

Submitting Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted:_____ Not Accepted:_____ Received Too Late:_____
By:_____ Date:_____
Remarks:_____

LICENSE, INDEMNITY AND WARRANTY AGREEMENT

BETWEEN: Bridgers & Paxton Consulting Engineers, Inc.

4600-C Montgomery Blvd NE

Albuquerque, New Mexico 87109

and the Contractor:

For use of CADD Database by the Contractor for:

PROJECT:_____

LICENSE:_____

1.1 LICENSE GRANT: The Contractor is granted use of the CADD Database for the specific purpose of preparing submittal documents for the Project. No other use of the CADD Database is granted. Title to the CADD Database is not transferred to the Contractor.

1.2 COPYING RESTRICTIONS: The Contractor may copy the CADD Database in whole or in part, only for backup and archival purposes and for use by the Contractor's Subcontractors. All of the Contractor's Subcontractors who receive a copy of the CADD Database in whole or in part shall be bound by the terms and conditions of this Agreement.

1.3 TRANSFER OF CADD DATABASE: The Contractor may not transfer the CADD Database to any other party other than as specified in Section 1.2 of this Agreement.

WARRANTY

2.1 DATABASE WARRANTY: Bridgers & Paxton Consulting Engineers, Inc. disclaims all warranties with regard to the database supplied hereunder, including all implied warranties of fitness. Bridgers & Paxton Consulting Engineers, Inc., disclaims all obligations or liabilities for damages, including, but not limited to, consequential damages rising out of or in connection with the use of performance of the database.

INDEMNITY

3.1 INDEMNITY: The Contractor recognizes that the use of the database will be at the Contractor's sole risk and without any liability, risk or legal exposure by Bridgers & Paxton Consulting Engineers, Inc. The Contractor recognizes that it is impossible for the Engineer to assure the accuracy, completeness and sufficiency of such information, either because it is impossible to verify, or because of errors or omissions which may have occurred in assembling the information the Engineer is providing. Furthermore, in that these CADD Database files are considered to be information furnished to the Contractor by others, it shall be the Contractor's sole responsibility to verify dimensions in the drawings prior to using these database files for his intended purpose. Furthermore, the Contractor shall, to the fullest extent permitted by law, defend, indemnify and hold harmless Bridgers & Paxton Consulting Engineers, Inc., from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the database.

COMPENSATION

3.2 COMPENSATION: The Contractor shall compensate Bridgers & Paxton for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc. No time shall be expended making any substantive changes to the drawings. The cost for this time will be billed at the rate of $75.00 / Hour. It is not anticipated that more than four (4) hours will be required to complete this task. An invoice will be generated and delivered with the drawing files. Payment for the services shall be made within thirty (30) days of the receipt of the invoice.

ACKNOWLEDGMENT

4.1 ACKNOWLEDGMENT: The Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Authorized Signature: _____

Title: _____

Date: _____

BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.

Authorized Signature: _____

Title: _____

Date: _____

SECTION 260502 - DEMOLITION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 1 Specification Sections apply to this Section.

B. See Section 26 0500 for Common Work Results for Electrical.

1.2 SCOPE OF WORK

A. Provide all material, equipment and labor as required to remove, relocate and/or reconnect all electrical work identified in these specifications and indicated on the drawings.

1.3 SUMMARY

A. This Section includes limited scope, general construction materials and methods for application with electrical installations as follows:

1. Selective demolition including:

    a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
    b. Dismantling electrical materials and equipment made obsolete by these installations.

2. Excavation for underground utilities and services, including underground raceways.
3. Miscellaneous metals for support of electrical materials and equipment.
4. Nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
5. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
6. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment.

B. Contractor will ring out all circuits from with-in electrical equipment being removed, replaced, or relocated. Existing circuits required to remain after demolition occurs will be reconnected or reconfigured. This includes General Purpose Receptacles, lighting, lighting control/devices, mechanical/plumbing equipment, and technology systems that require power maintained. Contractor will ensure that all parts of the existing facility left after demolition is complete is operable for use.

1.4 PROJECT CONDITIONS

A. Conditions affecting selective demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions affecting excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
3. Existing utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
4. Remove existing underground utilities indicated to be removed.

    a. Uncharted or incorrectly charted utilities: Contact utility owner immediately for instructions.
    b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Owner's Representative prior to utility interruption.

5. Use of explosives is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Verify field measurements and circuiting arrangements as shown on drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect/Engineer before disturbing existing installation.

E. Beginning of demolition means Contractor accepts existing conditions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Disconnect and remove electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with Owner a minimum of 72 hours prior to outage.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing electrical services: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from the Owner's Representative at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Cafeteria/Kitchen building systems (typical for all electrical, lighting and communications systems – refer to drawings for additional information): Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from the Owner's Representative at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of this section.

B. Remove, relocate and extend existing installations to accommodate new construction.

C. Recircuit and reconnect all electrical lighting, outlets, and equipment not scheduled for removal that have become disconnected due to demolition work.

D. Remove abandoned wiring to source of supply.

E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit serving them is removed. Provide blank cover for abandoned outlets which are not removed. Provide blank cover for abandoned outlets which are not removed.

G. Disconnect and remove abandoned panelboards and distribution equipment.

H. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

I. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.

J. Repair adjacent construction and finishes damaged during demolition and extension work. Any damage to building, piping or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.

K. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

L. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

M. Removal and replacement of ceiling tile(s) to perform work operations shall be the responsibility of the Contractor. The Contractor shall be responsible for replacement of any ceiling tiles or framework that may become damaged at no cost to the Owner

N. Housekeeping Pads and Equipment Foundations: Remove for all equipment removal. Backfill as required, compact to 95 percent modified Proctor density, and pour floor slab or resurface floor to match existing.

O. Conduit in Concealed Locations: Remove conductors, cap both ends of conduit, and label conduit as "Abandoned" at both ends. Where conduit runs below grade, cap both ends of conduit and abandon in place. Where conduit runs below floor slab, additionally, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match existing.

P. Motor Control Centers: Where MCCs serve equipment to be removed and no new equipment is to be served, leave starter in place, remove existing labels, and install new label "Spare Size x Starter."

3.3 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaries: Remove existing luminaries for cleaning, as indicated on drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

D. Materials and equipment to be salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

E. Disposal and cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

3.4 INSTALLATION

A. Install relocated materials and equipment under the provisions of this section.

3.5 ITEMS SALVAGED TO OWNER

A. Items salvaged to Owner are as indicated on drawings. Move and store in dry location as directed. Refuse materials and items not salvaged shall be removed from the site and legally disposed of.

END OF SECTION 260502

SECTION 260519 - LOW VOLTAGE POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26, Section 26 0529, Hangers and Supports for Electrical Systems for supports and anchors for fastening cable directly to building finishes.
2. Division 26, Section 26 0553, Identification for Electrical Systems for insulation color coding and wire and cable markers.
3. Division 28, Section 28 0513, Conductors and Cables for Electronic Safety and Security.

1.3 SUBMITTALS

A. Field test reports indicating and interpreting test results relative to compliance with performance requirements of testing standard.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control Services," an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).

1. Testing Agency's Field Supervisor Qualifications: A person currently certified by the NETA National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

C. Comply with NFPA 70 National Electrical Code for components and installation.

1.5 SEQUENCING AND SCHEDULING

A. Coordination: Coordinate layout and installation of cable with other installations.

B. Revise locations and elevations from those indicated as required to suit field conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable according to NEMA WC-26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wires and Cables:
   a. American Insulated Wire Corporation, Leviton Manufacturing Co.
   b. Brand-Rex Cable Systems, Brintec Corp.
   c. Carol Cable Company, Inc.
   d. Senator Wire & Cable Co.
   e. Southwire Co.

2. Connectors for Wires and Cables:
   a. AMP, Inc.
   b. Anderson, Square D Co.
   c. Electrical Products Division, 3M Co.
   d. O-Z/Gedney Unit, General Signal

2.2 BUILDING WIRES AND CABLES

A. UL listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Applications" Article.

B. Rubber Insulation: Comply with NEMA WC 3.

C. Thermoplastic Insulation: Comply with NEMA WC 5.

D. Cross-Linked Polyethylene Insulation: Comply with NEMA WC 7.

E. Ethylene Propylene Rubber Insulation: Comply with NEMA WC 8.

F. Conductor Material: Copper.

1. Aluminum will be allowed ONLY IF INDICATED ON DRAWINGS and for feeders (only) rated 100 Amps or higher. Under no circumstance shall aluminum be permitted for branch circuits, including those supplying large-ampacity equipment loads.

G. Solid conductor for 10 AWG and smaller; stranded conductor for larger than 10 AWG. Stranded conductor for controls and connections subject to vibration.

2.3 CONNECTORS AND SPLICES

A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with Project's installation requirements and as specified in Part 3 "Applications" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Service Entrance: Type RHW or THWN, copper conductor, in raceway.

B. Feeders: Type THHN/THWN.

C. Branch Circuits:

1. Type THHN-THWN, single conductors in raceway.
2. Minimum size conductors will #12.

D. Fire Alarm Circuits: Power-limited fire protective signaling circuit cable, and Type THHN/THWN, copper conductor, in raceway.

E. Class 1 Control Circuits: Type THHN/THWN, copper conductor, in raceway.

F. Class 2 Control Circuits: Power-limited tray cable, in cable tray, Power-limited cable, concealed in building finishes.

G. Ampacity: Use 60ºC rating only for sizes #14 AWG through #1 AWG unless otherwise noted.

3.3 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA "Standard of Installation."

B. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.

1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

C. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

D. Conductor Splices: In branch circuits and if kept to minimum. No splices in services or feeders.

1. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
2. Use splice and tap connectors that are compatible with conductor material.
3. Crimp type "quick connect" style wire connectors are not permitted.

E. Wiring at Outlets: Install with at least 12 inches of slack conductor at each outlet.

F. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.4 FIELD QUALITY CONTROL

A. Testing: Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.

B. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:

1. Division 26, Section 26 0543, Underground Ducts & Raceways for Electrical Systems for ground test wells.
2. Division 26, Section 26 4113, Lightning Protection for Structures, for additional grounding and bonding materials.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For firms and persons specified in ‘Quality Assurance’ Article.

C. Field Test Reports: Submit written test reports to include the following:

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.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise onsite testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for

intended use.

1. Comply with UL 467.

C. Comply with NFPA 70; for overhead line construction and medium voltage underground construction, comply with IEEE C2.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Grounding Conductors, Cables, Connectors, and Rods:

a. Apache Grounding/Erico Inc.
b. Boggs, Inc.
c. Chance/Hubbell
d. Copperweld Corporation
e. Dossert Corporation
f. Erico Inc., Electrical Products Group
g. Framatome Connectors/Burndy Electrical
h. Galvan Industries, Inc.
i. Harger Lightning Protection, Inc.
j. Hastings Fiber Glass Products, Inc.
k. Heary Brothers Lightning Protection Co.
l. Ideal Industries, Inc.
m. Ilsco
n. Kearney/Cooper Power Systems
o. Korns: C.C. Korns Co., Division of Robroy Industries
p. Lightning Master Corporation
q. Lyncole XIT Grounding
r. O-Z/Gedney Company; a business of the EGS Electrical Group
s. Raco, Inc., Division of Hubbell
t. Robbins Lightning, Inc.
u. Salisbury: W.H. Salisbury & Company
v. Superior Grounding Systems, Inc.
w. Thomas & Betts, Electrical

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26, Section 26 0519, Low-Voltage Electrical Power.

B. Equipment Grounding Conductors: Insulated with green colored insulation.

C. Isolated Ground Conductors: Insulated with green colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B3.
2. Assembly of Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

H. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 4 AWG minimum, soft drawn copper conductor.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure treated fir, cypress or cedar.

I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted pressure type connectors, or compression type.

C. Welded Connectors: Exothermic welded type, in kit form, and selected per manufacturer's

written instructions.

D. Irreversible Compression Connectors: In kit form, selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Sectional type copper-clad steel.

1. Size: 3/4 by 120 inches in diameter.

B. Chemical Electrodes: UL listed, copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

C. Test Wells: Provide handholes as specified in Division 26, Section 26 0543, Underground Ducts and Raceways for Electrical Systems.

D. Ground Bar: 12 inches long or greater length as indicated on the drawings, fabricated from 1/4 inch thick, 4 inch wide copper stock with 1.75 inch x 1.75 inch NEMA bolt hole pattern. Mount ground bar on 2700V standoff insulators.

E. Ground Electrode Backfill Material:

1. Bentonite clay or equivalent commercial ground enhancement backfill material for ground rods and cable type electrodes.
2. Backfill material, when at 300% moisture content ((weight of water/weight of material) x 100) shall have a resistivity of approximately 250 ohm-cm and a pH of 8 to 10.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections or Irreversible Compression Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two (2) bolts.

F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space one-inch from wall and support from wall six-inches above

finished floor, unless otherwise indicated.

2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

G. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250 for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install insulated equipment grounding conductors in all feeders and circuits.

C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch circuit runs from computer area power panels or power distribution units.

E. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

I. Air Duct Equipment Circuits: Install an equipment grounding conductor to duct mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

J. Water Heater, Heat Tracing, and Antifrost heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment and components.

K. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4 x 2 x 12 inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

L. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch circuit conductors.

M. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.3 MAIN GROUNDING ELECTRODE SYSTEM

A. Use the building concrete grade beam to make a concrete encased main grounding electrode; conductor shall be a copper ground cable:

1. Make one reinforcing bar, located in the bottom one-third of the footing, electrically continuous around the entire perimeter of the building. The reinforcing bar shall be at least #6 size and uncoated. Bond the reinforcing bars together by exothermically welding #4/0 AWG ground cable across splices.

B. Where it is not possible to use the building grade beam as a concrete encased electrode, or the main grounding electrode must be supplemented, use the following made electrodes:

1. Install a counterpoise of #4/0 AWG ground cable located 2 feet outside the building perimeter and at least 2 feet below grade. Encase the counterpoise in a 2 inch slurry envelope of ground electrode backfill material.

3.4 COUNTERPOISE

A. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned copper conductor not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches below grade and 24 inches from building foundation.

3.5 INSTALLATION

A. Ground Rods: Install at least three (3) rods spaced at least one rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

1. Where grounding conductors are required in PVC conduit or bare, do not completely encircle conduit or conductor with steel clamp or other steel devices.
2. Where grounding conductor is routed in steel conduit, bond both ends of conduit to grounding conductor with full size conductor.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic welded connectors for outdoor locations, unless a disconnect type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans blowers, electric heaters, and air cleaners. Use braided type bonding straps.

G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

H. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.

I. Ufer Ground (Concrete Encased Grounding Electrode): Fabricate according to NFPA 70, Paragraph 250-81(c), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four (4) locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

J. Electrical Room Grounding Bus: Space 1 inch from wall and support from wall 6 inches above finished floor, except as otherwise indicated.

3.6 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure type connectors.

D. Non-contact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use compression type connectors on conductors and make bolted and clamped type connections between conductors and ground rods.

F. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.

G. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

H. Compression Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

I. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.7 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Duct Banks: Install a grounding conductor with at least 50 percent ampacity of the largest phase conductor in the duct bank, or if conductor size is not known use 4/0 AWG.

B. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure sensitive tape or heat shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad Mounted Transformers and Switches: Install two (2) ground rods and counterpoise circling pad. Ground pad mounted equipment and non-current carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control testing:

1. After installing grounding system, but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two (2) full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall of potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

a.	Equipment Rated 500 kVA and Less:	10 ohms
b.	Equipment Rated 500 to 1000 kVA:	5 ohms
c.	Equipment Rated More Than 1000 kVA:	3 ohms

d. Substations & Pad Mounted Switching Equipment: 5 ohms
e. Manhole Grounds: 10 ohms

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.9 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by work of this section. Re-establish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2, Section 'Landscaping'. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Related Sections: The following Sections contains requirements that relate to this Section:

1. Division 26, Section 26 0500, Common Work Results for Electrical.
2. Division 5, Section Metal Fabrications for requirements for miscellaneous metal items involved in supports and fastenings.
3. Refer to other Division 26 sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified.

1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

C. Shop drawings indicating details of fabricated products and materials.

D. Engineered Design consisting of details and engineering analysis for supports for the following items:

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70, National Electrical Code.

B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work, shall include the following:

1. Slotted Metal Angle and U-Channel Systems:

a. Allied Tube & Conduit
b. American Electric
c. B-Line Systems, Inc.
d. Cinch Clamp Co., Inc.
e. GS Metals Corp.
f. Haydon Corp.
g. Kin-Line, Inc.
h. Unistrut Diversified Products

2. Conduit Sealing Bushings:

a. Bridgeport Fittings, Inc.
b. Cooper Industries, Inc.
c. Elliott Electric Mfg. Corp.
d. GS Metals Corp.
e. Killark Electric Mfg. Co.
f. Madison Equipment Co.
g. L.E. Mason Co.
h. O-Z/Gedney
i. Producto Electric Corp.
j. Raco, Inc.
k. Red Seal Electric Corp.
l. Spring City Electrical Mfg. Co.
m. Thomas & Betts Corp.

2.2 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.

2. Toggle Bolts: All steel springhead type.
3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.4 FABRICATED SUPPORTING DEVICES

A. General: Shop or field fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheetmetal: Fabricate from galvanized sheetmetal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:

a.	3-inch and smaller:	20-gauge
b.	4-inch to 6-inch:	16-gauge
c.	over 6-inch:	14-gauge

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheetmetal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

G. Sleeves: Install in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.

H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheetmetal screws.
2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

J. Tests: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.
3. Powder-driven threaded studs.

K. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the Contracting Officer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

3.2 TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size, In.	Location	RMC & IMC (1)	EMT (1)
1/2-1	Any Location	7	7
1 & Larger	Any Location	10	10

NOTES:
(1) Maximum spacing of supports (feet).
(2) Maximum spacings for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.

Abbreviations:		
	EMT	Electrical metallic tubing.
	IMC	Intermediate metallic conduit.
	RMC	Rigid metallic conduit.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL 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 includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Raceways include the following:

1. Rigid metal conduit.
2. Intermediate metal conduit.
3. Polyvinyl chloride (PVC) externally coated rigid steel conduit.
4. PVC externally coated intermediate metal conduit.
5. Electrical metallic tubing (EMT).
6. Flexible metal conduit.
7. Liquidtight flexible conduit.
8. Rigid nonmetallic conduit.
9. Wireway.
10. Surface raceways.

C. Boxes, enclosures, and cabinets include the following:

1. Device boxes.
2. Floor boxes.
3. Outlet boxes.
4. Pull and junction boxes.
5. Cabinets and hinged cover enclosures.

D. Related Sections: The following Sections contain requirements that relate to this Section:

1. See Division 7, Section Firestopping.
2. See Division 26, Section 26 0529, Hangers and Supports for Electrical Systems.
3. See Division 26, Section 26 0534, Floor Boxes For Electrical Systems
4. See Division 26, Section 26 0543, Underground Ducts and Raceways for Electrical Systems.
5. See Division 26, Section 26 2726, Wiring Devices.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for surface raceway, wireway and fittings, floor boxes, hinged cover enclosures, and cabinets.

C. Shop drawings for nonstandard boxes, enclosures, and cabinets. Include layout drawings showing components and wiring.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, National Electrical Code, for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

C. Comply with NECA "Standard of Installation."

D. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

1.5 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RNC: Rigid nonmetallic conduit.

F. MC: Metal Clad Cable. A factory assembly of one or more insulated conductors enclosed in an armor of interlocking metal tape, or a smooth corrugated metallic sheath.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide Products by of one of the following:

1. Metal Conduit and Tubing:

a. Monogram Co., AFC.
b. Alflex Corp.
c. Allied Tube and Conduit, Grinnell Co.
d. Anamet, Inc., Anaconda Metal Hose.

e. Anixter Brothers, Inc.
f. Carol Cable Co., Inc.
g. Cole-Flex Corp.
h. Flexcon, Inc., Coleman Cable Systems, Inc.
i. Spiraduct, Inc.
j. Triangle PWC, Inc.
k. Wheatland Tube Co.

2. Nonmetallic Conduit:

a. Anamet, Inc., Anaconda Metal Hose.
b. Arnco Corp.
c. Breeze-Illinois, Inc.
d. Can-Tex Industries, Harsco Corp.
e. Carlon.
f. Certainteed Corp, Pipe & Plastics Group.
g. Cole-Flex Corp.
h. Condux International, Electrical Products.
i. Electri-Flex Co
j. George-Ingraham Corp.
k. Hubbell, Inc., Raco, Inc.
l. R&G Sloan Manufacturing Co., Inc.
m. Spiraduct, Inc.
n. Thomas & Betts Corp.

3. Conduit Bodies and Fittings:

a. Scott Fetzer Company, Adalet-PLM.
b. American Electric, Construction Materials Group.
c. Emerson Electric Co., Appleton Electric Co.
d. Carlon
e. Hubbell, Inc., Killark Electric Manufacturing Co.
f. General Signal, O-Z/Gedney Unit
g. Spring City Electrical Manufacturing Co.

4. Wireway:

a. Hoffman Engineering Co.
b. Keystone/Rees, Inc.
c. Square D Co.

5. Surface Metal Raceway:

a. Airey-Thompson Co., Inc., A-T Power Systems
b. American Electric, Construction Materials Group
c. Butler Manufacturing Co., Walker Division
d. The Wiremold Co., Electrical Sales Division
e. Mono Systems

6. Surface Nonmetallic Raceway:

a. Anixter Brothers, Inc.
b. Butler Manufacturing Co., Walker Division
c. Hubbell, Inc., Wiring Device Division
d. JBC Enterprises, Inc., Enduro Fiberglass Systems
e. Panduit Corp.
f. United Telecom, Premier Telecom Products, Inc.
g. Thermotools Co.
h. The Wiremold Co., Electrical Sales Division
i. Mono Systems

7. Boxes, Enclosures, and Cabinets:

a. Scott Fetzer Company, Adalet-PLM
b. Butler Manufacturing Co., Walker Division
c. Cooper Industries, Midwest Electric
d. Electric Panelboard Co., Inc.
e. Erickson Electrical Equipment Co.
f. American Electric, FL Industries
g. Hoffman Engineering Co., Federal-Hoffman, Inc.
h. Hubbell Inc., Killark Electric Manufacturing Co.
i. General Signal, O-Z/Gedney
j. Parker Electrical Manufacturing Co.
k. Raco, Inc., Hubbell Inc.
l. Robroy Industries, Inc., Electrical Division
m. Spring City Electrical Manufacturing Co.
n. Square D Co.
o. Thomas & Betts Corp.
p. Woodhead Industries, Inc., Daniel Woodhead Co.

2.2 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. Intermediate Metal Conduit: ANSI C80.6.

C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

D. Plastic-Coated Intermediate Metal Conduit and Fittings: NEMA RN 1.

E. Electrical Metallic Tubing and Fittings: ANSI C80.3 with compression-type, steel fittings. Set-screw fittings are not permitted. Cast metal fittings are not permitted.

F. Flexible Metal Conduit: Aluminum or Zinc Coated Steel.

G. Liquidtight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.

H. Fittings: NEMA FB 1, compatible with conduit/tubing materials.

2.3 NONMETALLIC CONDUIT

A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2, Schedule 40 or 80 PVC.

B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.4 WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireway as required for complete system.

C. Select features where not otherwise indicated, as required to complete wiring system and to comply with NEC.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAY

A. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceway.

B. Surface Metal Raceway: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating suitable for painting.

C. Surface Nonmetallic Raceway: 2-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.

2.6 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1.

B. Cast Metal Boxes: NEMA FB 1, type FD, cast feralloy box with gasketed cover.

C. Nonmetallic Boxes: NEMA OS 2.

2.7 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1.

B. Cast Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.8 CABINETS AND ENCLOSURES

A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.9 FLOOR BOXES

A. See Division 26, Section 26 0534, Floor Boxes For Electrical Systems

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods, 3/4” minimum trade size:

1. Exposed: Rigid or intermediate metal conduit.
2. Concealed: Rigid or intermediate metal conduit.
3. Underground, Single Run: Rigid nonmetallic conduit.
4. Underground, Grouped: Rigid nonmetallic conduit.
5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.
6. Boxes and Enclosures: NEMA Type 3R or Type 4.

B. Indoors: Use the following wiring methods, 3/4" minimum trade size except as noted below:

1. Connection to Vibrating Equipment and Light Fixtures: (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit, except in wet or damp locations use Liquidtight flexible metal conduit, 1/2" trade size minimum.
2. Connection to Light Fixtures: 1/2” trade size minimum, flexible metal conduit, except in wet or damp locations use Liquidtight flexible metal conduit, or solid connection using material conforming to requirements for materials specified in this Paragraph B.
3. Damp or Wet Locations: Rigid steel conduit.
4. Exposed: Electrical metallic tubing.
5. Locations Subject to Physical Damage: Rigid or intermediate steel conduit.

6. Corrosive Locations: Plastic coated rigid steel or rigid non-metallic conduit.
7. Concealed: Electrical metallic tubing.
8. Boxes and Enclosures: NEMA Type 1, except in damp or wet locations use NEMA Type 4, stainless steel.
9. FMC / LFMC / MC: Use is restricted unless otherwise noted on drawings. FMC, LFMC, and MC are permitted in only the following locations:

    a. FMC/LFMC: All motor connections in lengths not less than 12 inches or more than 30 inches. All flexible conduit motor connections in damp locations shall have a liquid-tight covering. (Boiler rooms, mechanical equipment rooms and kitchens shall be considered as damp locations for this requirement).
    b. FMC/MC:

        1) Concealed within special equipment cabinets.

3.3 INSTALLATION

A. Provide 3/4” minimum trade size for all raceway types.

B. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. Support raceway as specified in Division 26, Section 26 0529, Hangers and Supports for Electrical Systems.

H. Use temporary closures to prevent foreign matter from entering raceway.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

J. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

K. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.

L. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.

M. Raceways Embedded in Slabs: NO CONDUITS SHALL BE PLACED WITHIN ANY CONCRETE SLABS EXCEPT AS SPECIFICALLY APPROVED BY THE ARCHITECT VIA

FORMAL REQUEST. Conduits are permitted to be installed/embedded within the earthwork below slabs on grade. Conduits are also permitted to be installed/routed within the interstitial space below slabs that are elevated above grade. Conduits are permitted to penetrate slabs, footings, stem walls, etc, as long as the penetrations are done in a perpendicular fashion

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

P. Tighten set screws of threadless fittings with suitable tool.

Q. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

R. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

S. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

T. Telephone and Signal System Raceways 2-Inch Trade Size and Smaller, unless otherwise noted on plans: In addition to the above requirements, install in maximum lengths of 150 feet and with a maximum of two 90-deg bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

U. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits enter or leave hazardous locations.
2. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
3. Where otherwise required by the NEC.

V. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the

finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Install insulated grounding bushings on each conduit and bond to ground system. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs flush with floor.

W. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use Liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

X. Do not install aluminum conduit embedded in or in contact with concrete.

Y. PVC Externally Coated Rigid Steel Conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

Z. Underground 90 degree elbows 2-inch trade size or larger, use plastic coated or tape wrapped intermediate metal or rigid steel conduit. Comply with NEC for grounding.

AA. Surface Metal Raceway: Install a separate green ground conductor in raceway from the junction box supplying the raceway to receptacle or fixture ground terminals.

1. Select each surface metal raceway outlet box to which a lighting fixture is attached to be of sufficient diameter to provide a seat for the fixture canopy.
2. Where a surface metal raceway is used to supply a fluorescent lighting fixture having central stem suspension with a backplate and a canopy (with or without extension ring), the backplate and canopy will serve as the outlet box and no separate outlet box need be provided.
3. Provide surface metal raceway outlet box, in addition to the backplate and canopy, at the feed-in location of each fluorescent lighting fixture having end stem suspension.
4. Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed (provide a backplate slightly smaller than the fixture canopy), no additional surface mounted outlet box need be installed.

BB. Set floor boxes level and adjust to floor surface.

CC. Install hinged cover enclosures and cabinets plumb. Support at each corner.

DD. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

EE. On all service, feeder, and branch circuit conduits, 2-inches and large, install grounding-type insulated bushings on each conduit entering all boxes, enclosures, and equipment. Bond conduit grounding bushing to a grounding bus in box, enclosure, or equipment with conductor sized per NEC 250-95. Do not use grounding conductor to bond bushing to grounding bus.

FF. All exposed conduit, fittings, boxes, hangers, clips, supports, etc., in finished areas to be painted per the Architect's/Engineer's instructions.

GG. Raceways and boxes under roof decking: Comply with NEC 300.4(E) for installation below roof decking.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.5 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Ducts in direct buried duct banks.
2. Ducts in concrete encased duct banks.
3. Handholes and handhole accessories.
4. Manholes and manhole accessories.

B. Related Sections include the following:

1. Division 26, Section 26 0520, Grounding and Bonding for Electrical Systems for grounding electrodes, counterpoise conductors, clamps and connectors for grounding metallic manhole and handhole accessories, and testing of grounds.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Manhole and handhole hardware.
2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
3. Duct bank materials, including spacers and miscellaneous components.
4. Warning tape.

B. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:

1. For manholes:

a. Duct sizes and locations of duct entries.
b. Reinforcement details.
c. Manhole cover design.
d. Step details
e. Grounding details.
f. Dimensioned locations of cable rack inserts, pulling-in irons, and sumps.

2. For precast manholes and handholes, shop drawings shall be signed and sealed by a qualified professional engineer and shall show the following:

a. Construction of individual segments.
b. Joint details.
c. Design calculations.

C. Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.

D. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.

E. Product Test Reports: Indicate compliance of manholes with ASTM C 857 and ASTM C 858, based on factory inspection.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories (Including Ducts for Communications and Telephone Service): Listed and labeled as defined in NFP A 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver ducts to project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect as least two (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect’s written permission.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by Architect.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Underground Precast Concrete Utility Structures:

    a. Brooks Products, Inc.
    b. Carder Concrete Products
    c. Christy Concrete Products, Inc.
    d. Elmhurst-Chicago Stone Company
    e. Riverton Concrete Products
    f. Rotondo Precast/Old Castle
    g. Utility Vault Company
    h. Wausau Concrete Company

2. Frames and Covers:

    a. Campbell Foundry Company
    b. East Jordan Iron Works, Inc.
    c. Mckinley Iron Works, Inc.
    d. Neenah Foundry Company

3. Nonmetallic Ducts and Accessories:

    a. Arnco Corporation
    b. Beck Manufacturing Inc.
    c. Cantex, Inc.
    d. Certainteed Corporation, Pipe & Plastics Group
    e. ElecSys, Inc.
    f. Electri-Flex Company

g. Ipex, Inc.
h. Lamson & Sessions; Carlon Electrical Products
i. Manhattan/CDT/Cole-Flex
j. Spiraduct/AFC Cable Systems, Inc.

2.2 CONDUIT

A. Conduit and fittings are specified in Division 26, Section 26 0533, Raceways and Boxes for Electrical Systems.

2.3 DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and 514B.

B. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-80-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Plastic Utilities Duct: NEMA TC 6, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 9.

D. Plastic Utilities Duct: NEMA TC 6, Type DB-60-PVC, ASTM F 512, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 9.

2.4 HANDHOLES

A. Enclosures, boxes and covers are required to conform to all test provisions of the most current ANSI/SCTE 77 “Specification For Underground Enclosure Integrity” for Tier 22 applications. When multiple “Tiers” are specified the boxes must physically accommodate and structurally support compatible covers while possessing the highest Tier rating. All covers are required to have the Tier level rating embossed on the surface. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box & cover) are manufactured using matched surface tooling. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.

B. Cast Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading.

C. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of handhole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.

D. Fiberglass Handholes: Molded fiberglass, with 6-inch square cable entrance at each side and weatherproof cover with nonskid finish and legend. Unit, when buried, shall be designed to support

AASHTO H10 loading.

E. Cover Legend:

1. 'ELECTRIC' for power, lighting, or other systems operating at 120 volts or greater.
2. ‘COMMUNICATIONS’ for phone, data, controls, fire alarm, or other signaling systems operating below 120 volts to ground.

2.5 CONSTRUCTION MATERIALS

A. Waterproofing: Comply with Division 7 Section 'Composite Sheet Waterproofing.'

B. Dampproofing: Comply with Division 7 Section ‘Bituminous Dampproofing.'

C. Mortar: Comply with ASTM C 270, Type M, except for quantities less than 2.0 Cu. Ft. where packaged mix complying with ASTM C 387, Type M, may be used.

D. Brick for Manhole Chimney: Sewer and manhole brick, ASTM C 32, Grade MS.

E. Concrete: Use 3000 PSI minimum, 28-day compressive strength and 3/8-inch maximum aggregate size. Concrete and reinforcement are specified in Division 3 Section 'Cast-in-Place Concrete.'

PART 3 - EXECUTION

3.1 APPLICATION

A. Underground Ducts for Electrical Utility Service: Type EPC-80-PVC, direct buried duct bank.

B. Underground Ducts for Electrical Cables Higher than 600V: Type EPC-80-PVC, direct buried duct bank.

C. Underground Ducts for Electrical Feeders: Type EB-35-PVC, concrete-encased duct bank.

D. Underground Ducts for Electrical Branch Circuits: Type DB-60-PVC, direct buried duct bank.

E. Underground Ducts for Telephone Utility Service: Type EPC-80-PVC, direct buried duct bank.

F. Underground Ducts for Communication Circuits: Type EPC-40 PVC, direct buried duct bank.

G. Manholes: Underground precast concrete utility structures.

H. Manholes: Cast-in-place concrete.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 2 Section, Earthwork, but do not use heavy duty hydraulic operated, compaction equipment. The entire depth of trench shall be backfilled in 12 inch

layers, and each layer shall be moistened and compacted to 95% below any walks, paving or structures and to 90% in open areas. Compaction shall be based on Standard Proctor Tests conducted on the materials used.

B. Restore disturbed pavement. Refer to Division 1 Section, Cutting and Patching.

3.3 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slop of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions.

B. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet, both horizontally and vertically, at other locations.

C. Use solvent cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches o.c. for 5 inch ducts and vary proportionately for other duct sizes. Change from regular spacing to end bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

E. Building Entrances: Make a transition from underground duct to conduit at least ten feet outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below.

1. Concrete Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Direct Buried, Nonencased Ducts at Nonwaterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Calk space between conduit and sleeve with duct sealing compound on both sides for moisture tight seal.
3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

F. Concrete Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting.

G. Stagger spacers approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

1. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4 inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
2. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
3. Forms: Use walls of trench to form side walls of duct bank where soil is self supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
4. Minimum Clearances Between Ducts: Three (3) inches between ducts and exterior envelope wall, two (2) inches between ducts for like services, and four (4) inches between power and signal ducts.
5. Depth: Install top of duct bank at least 24 inches below finished grade in no traffic areas and at least 30 inches below finished grade in vehicular traffic areas, unless otherwise indicated.

H. Direct Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts.
2. Install expansion fittings as shown on shop drawings.
3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 2, Section, Earthwork for pipes less than 6 inches in nominal diameter.
4. Backfill: Install backfill as specified in Division 2, Section, Earthwork. After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand temper only. After placing controlled backfill over final tier, complete backfilling normally.
5. Minimum Clearances Between Ducts: Three (3) inches between ducts for like services and six (6) inches between power and signal ducts.
6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

I. Warning Tape: Bury warning tape approximately 12 inches above all concrete encased duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.

J. Stub Ups: Use rigid steel conduit for stub ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.

K. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 PSIG hydrostatic pressure.

L. Pulling Cord: Install 100 lbf test nylon cord in ducts, including spares.

3.4 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

B. Grounding: Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26, Section 26 0526, Grounding and Bonding for Electrical Systems.

C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80% fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.5 CLEANING

A. Pull leather washer type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

SECTION 260550 - INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. See Division 21, Section 21 0549, Fire Protection & Electrical Installation Coordination.

B. See Division 22, Section 22 0549, Plumbing & Electrical Installation Coordination.

C. See Division 23, Section 23 0549, HVAC & Electrical Installation Coordination

D. See Mechanical Drawings for control requirements and for items requiring 120V (or greater) power.

E. See Technology / Special Systems Drawings and Sections (Divisions 27 and 28) for items requiring raceways, J-hooks, cable trays/baskets, supports, backing, rough-in, 120V (or greater) power, and/or low-voltage (below 120V) signal and communications wiring/cabling.

1. See Division 27 Sections for Communications Systems.
2. See Division 28 Sections for Electronic Safety and Security Systems.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION 260550

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL 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 includes identification of electrical materials, equipment, and installations.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of product specified.

C. Schedule of identification nomenclature to be used for identification signs and labels.

D. Samples for each color, lettering style, and other graphic representation required for identification materials; samples of labels and signs.

E. Details of EIA/TIA 606 compliance for labeling.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with EIA/TIA 606 for telephone, data, and fiber optic systems.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

B. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Labelmark Co.; Labelmaster Subsidiary
2. Brady USA, Inc.; Industrial Products Div.
3. Calpico, Inc.
4. Carlton Industries, Inc.
5. Champion American, Inc.
6. Cole-Flex Corp.
7. D&G Sign and Label
8. EMED Co., Inc.
9. George-Ingraham Corp. (The)
10. Grimco, Inc.
11. Ideal Industries, Inc.
12. Kraftbilt
13. LEM Products, Inc.
14. Markal Corp.
15. National Band & Tag Co.
16. Panduit Corp.
17. Radar Engineers
18. Ready Made Sign Co.; Cornerstone Direct Corp. Div.
19. Seton Name Plate Co.
20. Standard Signs, Inc.

2.2 RACEWAY AND CABLE LABELS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.
2. Legend: Indicates voltage and service.

C. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend is over-laminated with a clear, weather- and chemical-resistant coating.

D. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic bands sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

E. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

F. Underground Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

1. Size: Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed Legend: Indicates type of underground line.

G. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

H. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

I. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.

J. Aluminum-Faced Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture-resistant acrylic adhesive, and punched for the fastener. Preprinted legends suit each application.

K. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 inches by 0.05 inch.

2.3 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Engraving stock, melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 sq. in., 1/8 inch thick for larger sizes.

1. Engraved Legend:

a. Normal Power – White letters on black face, unless noted otherwise on drawings.
b. Emergency Power – White letters on red face, unless noted otherwise on drawings.
c. UPS Power – White letters on blue face, unless noted otherwise on drawings.

2. Punched for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for the application. 1/4-inch grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties with the following features:

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb minimum.
3. Temperature Range: Minus 40 to 185 deg F (Minus 4 to 85 deg C).
4. Color: As indicated where used for color coding.

B. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

F. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime Surfaces: For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty, acrylic-resin block filler. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.
3. Apply one intermediate and one finish coat of silicone alkyd enamel.
4. Apply primer and finish materials according to manufacturer's instructions.

G. Identify Raceways and Exposed Cables with Color Banding: Band exposed and accessible raceways of the systems listed below for identification.

1. Bands: Pre-tensioned, snap-around, colored plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit,

and place adjacent bands of 2-color markings in contact, side by side.

2. Locate bands at changes in direction, at penetrations of walls and floors, at 20-foot maximum intervals in straight runs, and at 10 feet in congested areas.
3. Colors: As follows:

    a. 120/208 Volt – Black.
    b. 277/480 Volt – Blue.
    c. Emergency 120/208 Volt – Black and orange.
    d. Emergency 277/480 Volt – Blue and orange.
    e. Fire-Alarm System: Red.
    f. Fire-Suppression Supervisory and Control System: Red and yellow.
    g. Combined Fire-Alarm and Security System: Red and blue.
    h. Security System: Blue and yellow.
    i. Mechanical and Electrical Supervisory System: Green and blue.
    j. Telecommunications System: Green and yellow.

H. Install Caution Signs for Enclosures Over 600 V: Use pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange field. Install on exterior of door or cover.

I. Install Circuit Identification Labels on Boxes: Label externally as follows:

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

J. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches, use a single line marker.

1. Install line marker for underground wiring, both direct buried and in raceway.

K. Color-Code Conductors: Secondary service, feeder, and branch circuit conductors throughout the secondary electrical system.

1. 208/120-V System: As follows:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
    d. Neutral: White.
    e. Ground: Green.

2. 480/277-V System: As follows:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Neutral: Grey.

e. Ground: Green.

3. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu of factory-coded wire for phase conductor's sizes larger than No. 10 AWG and grounded conductors and grounding conductors larger than No. 6 AWG.

a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
b. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

L. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Fasten tags with nylon cable ties; fasten bands using integral ears.

M. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

N. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

O. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/2-inch high

lettering on 1-1/2-inch high label; where 2 lines of text are required, use lettering 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.

2. Example: Panel 1H1 120/208V, 3-PH, 4-wire fed from panel MDR-CCT#4.

    a. Panelboards, electrical cabinets, and enclosures.
    b. Access doors and panels for concealed electrical items.
    c. Electrical switchgear and switchboards.
    d. Electrical substations.
    e. Motor control centers.
    f. Motor starters.
    g. Push-button stations.
    h. Power transfer equipment.
    i. Contactors.
    j. Remote-controlled switches.
    k. Dimmers.
    l. Control devices.
    m. Switches and receptacles.
    n. Transformers.
    o. Inverters.
    p. Rectifiers.
    q. Frequency converters.
    r. Battery racks.
    s. Power-generating units.
    t. Telephone switching equipment.
    u. Clock/program master equipment.
    v. Call system master station.
    w. TV/audio monitoring master station.
    x. Fire-alarm master station or control panel.
    y. Security-monitoring master station or control panel.

3. Circuits: Apply identification labels of engraved metallic dyno on each switch and receptacle indicating panelboard and circuit number supplying receptacle.
4. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

a. Circuit-breaker and fuse-current ratings and types.
b. Relays and associated power and current transformer ratings and ratios.
c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
d. Generator kilovolt amperes, size, voltage, and source impedance.
e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
f. Busway ampacity and impedance.
g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

    1. Switchgear and switchboard bus.
    2. Medium-voltage controller.
    3. Motor-control center.
    4. Distribution panelboard.
    5. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

    1. Transformers:

        a. ANSI C57.12.10.
        b. ANSI C57.12.22.
        c. ANSI C57.12.40.

d. IEEE C57.12.00.
e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

    a. Device tag.
    b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    d. Fuse-current rating and type.
    e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

    a. Device tag.
    b. Voltage and current ratio for curves.
    c. Three-phase and single-phase damage points for each transformer.
    d. No damage, melting, and clearing curves for fuses.
    e. Cable damage curves.
    f. Transformer inrush points.
    g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 260573

SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Specialist.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: available software developers offering software that may be used for the Work include, but are not limited to, the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

G. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 75 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. The calculations shall include the ac fault-current decay from induction motors and shall apply to low-voltage, three-phase ac systems.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Switchgear.
3. Low-voltage switchgear.
4. Motor-control centers.
5. Standby generators and automatic transfer switches.
6. Branch circuit panelboards.

3.3 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.4 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support coordination study.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
5. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
6. Motor horsepower and NEMA MG 1 code letter designation.
7. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.5 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260574

SECTION 260800 - ELECTRICAL FACILITY STARTUP/COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope Of The Work

1. The purpose of this section is to specify Division 26 responsibilities and participation in the commissioning process. The owner will hire the Commissioning Authority for the project.
2. The Contractor is responsible to provide support to the Commissioning Authority as required for start-up, testing, and commissioning. The commissioning process requires significant participation of Division 26 to ensure all portions of the work have been completed in a satisfactory and fully operational manner.
3. The Contractor is responsible to provide complete “turnkey” start-up, testing, and commissioning for the lighting control systems. Refer to drawings and Division 26 specification sections pertaining to lighting controls for complete scope.

B. Minimum requirements for Contractor:

1. Start-up and testing of the equipment supplied.
2. Operate and maintain equipment and systems as required for commissioning tests.
3. Providing qualified personnel including equipment manufacturer's service technicians for participation with the commissioning team.
4. Provide equipment, materials, and labor necessary to correct deficiencies found during the commissioning process, which fulfill contract and warranty requirements.
5. Provide operation and maintenance information and record drawings for verification, organization, and distribution.
6. Provide assistance to the Commissioning Authority (CA) to develop and edit equipment startup and testing schedules (Commissioning Matrix).
7. Provide training for the systems specified in this division with coordination by the Contract Administrator and Commissioning Authority.
8. Attend commissioning meetings.

1.2 RELATED WORK

A. All start-up and testing procedures and documentation requirements specified within Division 26.

B. Allow sufficient time before final commissioning dates so that testing, adjusting and demonstration can be accomplished.

C. Put all electrical gear into full operation only after all testing has been completed, and the Commissioning Authority has received the testing documentation.

D. Provide labor and material to make corrections when required.

1.3 DEFINITIONS

A. Point Verification Forms (PVF) are detailed installation and startup tracking documents developed by the Commissioning Authority and completed through a cooperative effort between the Contractor and the Commissioning Authority. The PVFs will track each point through installation, termination, and connection to the Facility Management System (FMS).

B. Functional Performance Tests (FPT) are detailed testing procedure developed by the Commissioning Authority, and conducted through a cooperative effort between the Contractor and the Commissioning Authority. The FPTs will be detailed step by step procedures developed for each electrical system. The majority of electrical testing will be by the third party electrical testing firm. Commissioning Authority generated FPT's will be for systems such as lighting controls, dimmer controls, etc. Each FPT will have a clear acceptance criteria based in the contract documents which must be achieved before the system or sub-system is accepted by the Commissioning Authority and the Owner.

C. The Commissioning Authority (CA) is a firm hired directly by the Owner to oversee the entire commissioning process.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

A. This section will comply with Division 1 requirements for commissioning. If none are present what follows in this section will apply.

1. Complete all phases of work so the system can be tested, adjusted, and energized. Division 26 has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are fully functional and ready for testing and startup. This includes the complete installation of all equipment, materials, conduit, wire, supports, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.
2. A commissioning plan will be developed by the CA and approved by the commissioning team. Division 26 is obligated to assist the CA in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If system modifications/clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner. If Contractor initiated system changes have been made that alter the commissioning process, notify the Commissioning Authority and Contract Administrator for approval.
3. Specific pre-commissioning responsibilities of Division 26 are as follows:

    a. Bring each system to a fully construction completed state.

4. Commissioning is intended to begin upon completion of a system. To support Partial

Occupancy commissioning may proceed prior to the completion of systems, or sub-systems, and will be coordinated with the CA as equipment Early Run. Start of commissioning before system completion will not relieve Division 26 from completing those systems as per the schedule.

3.2 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start up all systems within Division 26. These same technicians shall be made available to assist the CA in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested, coordinated by the CA, and tracked on the Commissioning Matrix. Division 26 will ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustment, and/or problem resolutions.

B. System problems and discrepancies may require additional technician time or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Contract Administrator and CA reserve the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the commissioning team to complete the job.

3.3 WORK TO RESOLVE DEFICIENCIES

A. In some systems, misadjustment, misapplied equipment and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work will be completed under the direction of the Contract Administrator, with input from the Contractor, equipment supplier, and CA. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Contract Administrator will have final jurisdiction on the necessary work to be done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit completion of the commissioning process according to the schedule. Experimentation to render system performance will be permitted. If the CA deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the CA will notify the Owner indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.4 TRAINING

A. Participate in the training of the Owner's engineering and maintenance staff, as required in Divisions 26, on each system and related components. Training, in part, will be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids.

B. Training will be conducted by the Contractor and the equipment vendors.

C. Training for the Commissioning Team members on the Commissioning Plan will be provided by the CA. All Commissioning Team members are required to attend this training.

3.5 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 26, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. Red-line all drawings on two sets. Include architectural floor plans, elevations and details, and the individual electrical systems in relation to actual building layout in Division 26 as-built drawings.

B. Maintain as-built red-lines as required by Division 1. Given the size and complexity of this project, red-line drawings at completion of construction, based on memory of key personnel, is not satisfactory. Continuous and regular red-lining of drawings is considered essential and mandatory. Maintain these drawings in the construction trailer and make them available for inspection at any time.

3.6 MISCELLANEOUS SUPPORT

A. Division 26 shall remove and replace covers of equipment, open access panels, etc., to permit Contractor, Contract Administrator, or CA to observe equipment and controllers provided.

END OF SECTION 260800

SECTION 260880 - ELECTRICAL ACCEPTANCE TESTING

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. Refer to individual specification sections indicated below for tests to be performed and other requirements.

1.2 QUALITY ASSURANCE

A. Contractor perform inspections, tests, adjustments and settings as specified herein and in other sections.

B. The contractor shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. The contractor shall submit appropriate documentation to demonstrate that it satisfactorily complies with the following. An organization having a “Full Membership” classification issued by the InterNational Electrical Testing Association.

1. The contractor shall be provide unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing organization.
2. The Contractor shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

D. The Contractor shall utilize technicians who are regularly employed for testing services.

E. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make an informed judgment on the continued serviceability or nonservice-ability of the specific equipment. Technicians shall be certified in accordance with ANSI/NETA ETT–2000, Standard for Certification of Electrical Testing Technicians. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

1.3 PERFORMANCE CRITERIA

A. Perform acceptance testing, inspection, and calibration to assure that installed electrical systems and equipment, either Owner or Subcontractor supplied are:

1. Installed in accordance with design Specifications and manufacturer’s instructions.

2. Ready to be energized,
3. Operational and within industry and manufacturer's tolerances.

B. Refer to each specification section in Division 26 for testing of the specified equipment and systems and/or are to be inspected, tested and calibrated by the Contractor.

1.4 REGULATORY REQUIREMENTS

A. Make Inspections and tests in accordance with the applicable codes and standards of the following agencies except as provided otherwise herein:

1. InterNational Electrical Testing Association – NETA ATS latest Edition: Acceptance Testing Specifications.
2. ANSI/NETA ETT – 2000, Standard for the Certification of Electrical Testing Technicians
3. National Fire Protection Association – NFPA.

    a. ANSI/NFPA 70: National Electrical Code.
    b. ANSI/NFP A 70B: Recommended Practice for Electrical Equipment Maintenance.
    c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces.
    d. NFPA 99 & 101.

B. Use the following references:

1. Project design Specifications.
2. Project OVERCURRENT PROTECTIVE DEVICE STUDY – refer to Section 26 0573.
3. Manufacturer's instruction manuals applicable to each particular apparatus.
4. Project list of equipment to be inspected and tested.

1.5 GENERAL REQUIREMENTS

A. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:

    a. Occupational Safety and Health Act.
    b. Accident Prevention Manual for Industrial Operations, National Safety Council.
    c. Applicable state and local safety operating procedures.
    d. Owner's safety practices.
    e. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.

2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
3. The Contractor shall have a designated safety representative on the project to supervise operations with respect to safety.

B. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.

2. Split-core current transformers and clamp-on or tong-type ammeters require consideration of the following in regard to accuracy:

    a. Position of the conductor within the core
    b. Clean, tight fit of the core pole faces
    c. Presence of external magnetic fields
    d. Accuracy of the current transformer ratio in addition to the accuracy of the secondary meter.

3. Selection of metering equipment shall be based on a knowledge of the waveform of the variable being measured. Digital multimeters may be average or RMS sensing and may include or exclude the dc component. When the variable contains harmonics or dc offset and, in general, any deviation from a pure sine wave, average sensing, RMS scaled meters may be misleading.
4. Field test metering used to check power system meter calibration must have accuracy higher than that of the instrument being checked.
5. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of two percent of the scale used.
6. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

C. Test Instrument Calibration

1. The Contractor shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
3. Instruments shall be calibrated in accordance with the following frequency schedule:

    a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
    b. Laboratory instruments: 12 months
    c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.

4. Dated calibration labels shall be visible on all test equipment.
5. Records, which show date and results of instruments calibrated or tested, shall be kept up-to-date.
6. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

D. Test Report

1. The test report shall include the following:

    a. Summary of project.
    b. Description of equipment tested.
    c. Description of test.
    d. Test data.
    e. Analysis and recommendations.

2. Test data records shall include the following minimum requirements:

a. Identification of the testing organization.
b. Equipment identification.
c. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.
d. Date of inspections, tests, maintenance, and/or calibrations.
e. Identification of the testing technician.
f. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
g. Indication of expected results when calibrations are to be performed.
h. Indication of “as-found” and “as-left” results.
i. Sufficient spaces to allow all results and comments to be indicated.

3. The contractor shall furnish a copy or copies of the complete report to the owner and Commissioning Authority as required in the acceptance contract.

1.6 SUBMITTALS

A. Qualifications of the contractor shall be submitted to the COMMISSIONING AUTHORITY for review with the electrical equipment submittals in accordance with Section 26 0500, "COMMON WORK RESULTS FOR ELECTRICAL, Submittals."

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 GENERAL

A. Set all adjustable circuit breaker trip settings in accordance with the trip setting report from the ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.

B. Test, inspect and calibrate the following electrical equipment in strict accordance with applicable sections of NETA ATS-2003.

1. Electrical equipment shown on the electrical Drawings.
2. Electrical equipment specified in all Division 26 Specifications for the Site.
3. Electrical equipment furnished under other Divisions of the Specifications and connected under Division 26.

C. Perform acceptance tests and inspections prior to energizing equipment, unless where energization is required to perform specified tests.

D. Final acceptance will not occur before completion of the electrical acceptance tests, inspections and calibrations specified in this Section.

3.2 FIELD QUALITY CONTROL

A. Standards: Comply with applicable standards of the InterNational Electrical Testing Association (NETA), including standard ATS.

B. Acceptance Testing: After installing equipment and BEFORE electrical circuitry has been energized. Demonstrate product capability and compliance with requirements.

3.3 DIVISION OF RESPONSIBILITY

A. The Contractor shall provide all material, equipment, labor and technical supervision to perform such tests and inspections as specified herein.

B. The Contractor is responsible for programming all protective and alarming devices with the proper settings provided by the ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY. Settings shall not be changed or applied to any device without written authorization from the Owner.

C. The Contractor shall notify the Commissioning Authority and Owner immediately upon the discovery of any defective equipment or incorrect system design or installation.

D. The Contractor shall provide an experienced person on-site during energizing, with appropriate test equipment to provide assistance in the event of a malfunction during the system start-up process.

3.4 ACCEPTANCE TESTING PROCEDURES

A. Testing and acceptance procedures for the equipment and systems listed in Part 1 shall be as described in the individual equipment specification sections listed above.

END OF SECTION 260880

SECTION 260913 - LIGHTING CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of lighting controls:

1. Time switches.
2. Lighting contactors.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26, Section 26 0533, Raceway and Boxes for Electrical Systems, for general component identification and support requirements.
2. Division 26, Section 26 0553, Identification for Electrical Systems, and general identification requirements.
3. Division 26, Section 26 0800, Electrical Facility Startup / Commissioning, for turn-key startup of all programmable, networked, and/or software-based lighting control system(s).

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for lighting control equipment and systems components, including dimensions and data on features and components. Include wiring diagrams and elevation views of front panels of control and indicating devices. Include data on ratings. For flush control panels, submit color and finish options for selection. Also include the following:

1. Lists of ballast and lamp combinations compatible with dimmer systems, by manufacturer and catalog number.
2. Sound data, including operational tests of dimming systems.
3. Operational documentation for software.

C. Shop Drawings detailing assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

D. Wiring diagrams detailing specific systems tailored to this Project and differentiating between factory-installed and field-installed wiring.

E. Field test reports indicating and interpreting test results specified in Part 3 of this Section.

F. Maintenance data for lighting control equipment and systems components to include in the operation and maintenance manual specified in Division 1.

G. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

H. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

I. Software licenses and upgrades required by and installed for operation and programming of central lighting control panels “LCP’s”. Install software on the same personal computer “PC” workstation(s) as used for the monitoring and control as the Division 23 Facility Management System “FMS” / Energy Management System “EMS” / Building Automation System “BAS”.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

B. Comply with FCC Regulations of Part 15, Subpart J for Class A.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing

Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty signed by manufacturer and Installer agreeing to replace programmable lighting control system components that fail in materials or workmanship within the specified warranty period.

C. Warranty Period: 2 years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra products as described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents. Deliver extra materials to Owner.

1. Relays: Single-pole mechanically held, 1 for every 4 installed. Furnish at least one of each type.
2. Dimmer Modules: 1 for every 4 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide one of the products specified in on the drawings. Where no manufacturer is listed for the appropriate product category, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Contactors and Relays:

a. Square D Co.
b. Eaton Corporation
c. Siemens

2. Time Switches:

a. NSi Industries / Tork, Inc.
b. Intermatic, Inc.

2.2 CONTACTORS AND RELAYS

A. Comply with NEMA ICS 2.

B. Description: Devices are electrically operated and mechanically held. Number of poles and ratings are as indicated. Coordinate rating of each unit with type of load served, including tungsten filament and inductive-type loads.

C. Modular Single-Pole Relays: Split-coil, momentary-pulsed type, knockout mounting.

1. Low-Voltage Leads: 5-pin plug connector.
2. Pilot Contacts: Single pole.
3. Rated Capacity: 20 A, 125 VAC for tungsten filaments, and 20 A, 277 VAC for ballasts.
4. Endurance: 50,000 cycles at rated capacity.

D. Modular Relay Panels: Steel cabinets, preassembled with modular single-pole relays, transformer power supplies, and associated components.

1. Barriers separate low-voltage and line-voltage components.
2. Cover: Hinged, lockable type.
3. Directory: Mounted on back of door. Identifies relays and loads controlled.

2.3 TIME SWITCHES

A. Time Switches: Solid-state programmable units with alphanumeric display conforming to UL 917. Include the following features:

B. Time Switches: Electromechanical-dial type conforming to UL 917. Include the following features:

1. Astronomic dial.
2. Contacts: 2, rated 30 A at 277 VAC, except as otherwise indicated.
3. Pilot-Duty Contacts: 2, rated 2 A at 240 V, except as otherwise indicated.
4. Eight-Day Program: Uniquely programmable for each day of the week and holidays.
5. Skip-day mode.

2.4 MANUAL SWITCHES AND PLATES

A. Switches: Specification grade, modular, momentary push-button, low-voltage type.

1. Color: White, except as otherwise indicated.
2. Integral Pilot Light: Indicates when circuit is on. Use where indicated.
3. Locator Light: Internal illumination helps locate switch in the dark. Use where indicated.
4. Wall Plates: Match those specified in Division 26, Section 26 2726, Wiring Devices to materials, finish, and color. Use multigang plates where more than one switch is indicated at a location.
5. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment according to manufacturers' written instructions.

B. Mount control equipment according to manufacturers' instructions and Division 26, Section 26 2726, Wiring Devices.

C. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounted ones.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between control devices as specified in Division 26 Section 26 2726, Wiring Devices.

B. Wiring Method: Install all wiring in raceway as specified in Division 26, Section 26 0533, Raceway and Boxes for Electrical Systems.

C. Wiring Method: Install all wiring in raceway as specified in Division 26, Section 26 0533, Raceways and Boxes for Electrical Systems, except where run in accessible ceiling space, and gypsum board partitions.

D. Bundle, train, and support wiring in enclosures.

E. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26, Section 26 0553, for Identification for Electrical Systems.

B. Label each system control module with a unique designation. Make designations on elevated components readable from floor.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to test, adjust, and program lighting control systems.

B. Reports: Prepare written reports of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

C. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible organization and person.

D. Schedule visual and mechanical inspections and electrical tests with at least 7 days' advance notice.

E. Visual and Operational Inspections: Include the following inspections:

1. Inspect control components for defects and physical damage, NRTL labeling, and nameplate compliance with current Project Drawings.
2. Check tightness of electrical connections with torque wrench calibrated within previous 6 months. Use manufacturers recommended torque values.
3. Verify settings of photoelectric devices with photometer calibrated to National Institute for Science and Technology (NIST) standards within past 6 months.
4. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's instructions for routine functional operation.

F. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following tests according to manufacturer's instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate controls to demonstrate controls in a methodical sequence that cues and reproduces actual operating functions. Include testing of dimming equipment and ambient-light, programmable, and occupancy controls under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

G. Correct deficiencies disclosed by inspections and tests, make necessary adjustments, and retest deficient items. Verify that specified requirements are met.

3.5 ADJUSTING AND CLEANING

A. Occupancy Adjustments: Upon request within 1 year of date of Substantial Completion, make up to 3 on-site visits to Project site to assist in adjusting light levels, making program changes, and adjusting sensors and controls.

B. Repair scratches and mars of finish to match original finish. Clean equipment and devices internally and externally using methods and materials recommended by manufacturers.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Confirm correct communication wiring, initiate communications between panels, and program the lighting control system according to approved zone configuration schedules, time-of-day schedules, and input override assignments.

3.7 DEMONSTRATION

A. Training: Provide services of a factory-authorized service representative to demonstrate programmable lighting control system and to train Owner's maintenance personnel.

1. Train Owner's personnel to operate, service, maintain, adjust, and program equipment and system components. Allow at least 8 hours to conduct training. Schedule training with at least 7 days' advance notice. Use final approved operation and maintenance manual as a training aid throughout training. Use both classroom training and hands-on exercises.

END OF SECTION 260913

SECTION 260923 - DIGITAL OCCUPANCY AND DAYLIGHT MANAGEMENT CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital Occupancy and Daylighting Sensor Control
2. Emergency Lighting Control (if applicable)

B. Related Section

1. Section 26 0913 – Lighting Control Equipment.
2. Section 26 2416 – Panelboards.
3. Section 26 2726 – Wiring Devices.
4. Section 26 5113 – Interior Lighting.
5. Section 26 0500 – Common Work Results

C. Control Intent – Control Intent includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones
3. Initial time switch settings
4. Task lighting and receptacle controls
5. Emergency Lighting control (if applicable)

1.2 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)

B. Canadian Standards Association (CSA) (www.csa.ca).

C. International Electrotechnical Commission (www.iec.ch)

D. International Organization for Standardization (ISO)

E. National Electrical Manufacturers Association (NEMA) (www.nema.org)

F. WD1 (R2005) - General Color Requirements for Wiring Devices.

G. Underwriters Laboratories, Inc. (UL) (www.ul.com):

1. 916 – Energy Management Equipment.
2. 924 – Emergency Lighting

H. International Building (IBC) Current Issue

1.3 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:

1. Digital Room Controllers – Self configuring, digitally addressable one, two or three relays controllers with 0-10v control for ballasts (if applicable) and single relay application specific plug load controllers.
2. Digital Occupancy Sensors – Self configuring, digitally addressable and calibrated occupancy sensors with LCD screens and two way active Infra-Red (IR) configurations.
3. Digital Switches – Self configuring, digitally addressable push button switches, dimmers, and scene switches with two way active Infra-Red (IR) communications.
4. Analog and digital closed loop daylighting sensors - self-calibrating daylighting sensors that provide closed loop control to Room Controllers. Sensors and Room Controllers can provide single or multi-zone, on/off or dimming control for daylight harvesting.
5. Hand held remotes for room configuration – provides two way infrared communications to digital devices and allows complete configuration and reconfiguration of the device / room from 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send / receive / store of all room variables.
6. Hand held remotes for personal control – One, two, or four (scene) button remotes provide Infrared communications to a room. Remote controls will support ON/OFF, scene control and may be configured in the field to provide specific occupant requirements without special tools.
7. Digital Lighting Management (DLM) local network – Free topology, plug in wiring system (Cat 5e) for power and data to room devices.
8. Native BACnet Module (if applicable) – Provide MS/TP communications for Room to Room, or Room to Server communications.
9. Emergency Lighting Control Unit (ELCU)- allows any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.4 LIGHTING CONTROL APPLICATIONS

A. Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with manual-on functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and automatic-on occupancy sensors are more appropriate. Provide manual ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors with manual-on switches.
2. Bi-Level Lighting – Provide multi –level switched dimming controls in all spaces except toilet rooms, storerooms, library stacks, or applications where variable dimming is used.
3. Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide automatic ON of

plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.

4. Daylighted Areas. All luminaries within 15’ of windows or within 7’ of skylights (the daylighted zone) shall be separately controlled from luminaires outside of daylighted zones. Luminaires closest to the daylight aperture shall be separately controlled from luminaires farther from the daylight aperture, within the daylight zone.
5. Daytime set points for total illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
6. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.
7. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylight system may be designed to turn off ambient lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

B. Additional controls.

1. Provide occupancy/vacancy sensors for any enclosed office, conference room, meeting room, and training room. For spaces with multiple occupants or where line-of-sight may be obscured, provide ceiling- or corner-mounted with manual-on switches.
2. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four (4) pre-set lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to extinguish all lighting in the space.

1.5 SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

B. Shop Drawings (For Sensor Systems):

1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
2. Scale drawing for each area showing exact location of each sensor, switching module, and on-off-auto switch.

C. Product Data: Catalog sheets, specifications and installation instructions.

D. Include data for each device which:

1. Indicates where sensor is proposed to be installed.
2. Prove that the sensor is suitable for the proposed application.

1.6 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years experience in manufacture of lighting controls.

1.7 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0° to 40° C (32° to 104° F).
2. Relative humidity: Maximum 90 percent, non-condensing.

1.8 WARRANTY

A. Provide a five year complete manufacturer's warranty on all products to be free of manufacturers' defects.

1.9 MAINTENANCE

A. Spare Parts:

1. Provide 1 of each product to be used for maintenance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

1. Watt Stopper

a. System: Digital Lighting Management (DLM)

2. Basis of design product: Watt Stopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:

a. Watt Stopper Digital Lighting Management (DLM)

B. Substitutions:

1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
2. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 SINGLE / DUAL RELAY WALL SWITCH VACANCY SENSORS

A. Type PW: Manual ON, Automatic OFF Wall switch type passive infrared occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper PW-100, PW-200.

B. Type UW: Manual ON, Automatic OFF Wall switch type ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper UW-100, UW-200.

C. Type DSW: Manual ON, Automatic OFF Wall switch type dual technology, passive Infrared and ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper DSW-100, DSW-200.

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared, ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square footage coverage requirements for each area controlled, utilizing Room Controller modules and accessories which suits the lighting and electrical system parameters.

B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

1. Digital calibration and LCD entry for the following variables:

    a. Sensitivity,
    b. Time Delay
    c. PIR, Ultrasonic or Dual Technology activation
    d. Re-strike times.
    e. Walk-through mode

2. Two RJ-45 digital connections for DLM local network.
3. Two-way infrared communications port to allow remote programming through hand held commissioning tool.
4. Self contained push buttons for programming and control of room devices.
5. Device Status LED's including:

    a. Network Status LED to indicate data transmission
    b. Power LED to indicate the device has power
    c. LED for each sensor technology to indicate detected motion.

C. Units will provide for digital calibration and commissioning and will not have any dip switches or potentiometers for field settings

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required

E. Watt Stopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.4 DIGITAL WALL SWITCHES

A. Low voltage (RJ-45) momentary push button switches in 1,2,3,4 and 8 button configuration, decorator opening. Wall switches will include the following features:

1. Two way infrared communications port for use with personal and configuration remote controls.
2. LED's for status, programming, and troubleshooting including:
    a. One pilot LED for each button.
    b. One locator LED per switch.
3. Engraveable buttons
4. Dimming switches shall include seven LED's to indicate load levels.
5. Scene switches shall include pilot indication of scene selection.
6. Device Status LED's including:
    a. Network Status LED to indicate data transmission
    b. Power LED to indicate the device has power

B. Switches shall have two RJ-45 ports to allow connection to any other digital room device.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching

D. Watt Stopper product numbers: LMSW-101 / LMSW-102 / LMSW-103 / LMSW-104 / LMSW-108.

2.5 ROOM CONTROLLERS

A. Room Controllers automatically bind the room loads to the connected devices in the space without any tools or configuration requirements. Room Controllers shall be provided to match the room lighting load and control requirements and sequences. The controllers will be simple to install and will not have screw type connections, dip switches, potentiometers or require special mounting or configuration. The control units will include the following features:

1. Automatic room configuration to the most energy efficient sequence of operation based upon the devices in the room.
2. One or two relay configuration
3. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an Off-the-Shelf unit without requiring any configuration or setup.
4. Device Status LED's including:

a. Network Status LED to indicate data transmission.
b. Power LED to indicate the device has power.
c. Load status.

5. Quick installation features including:

a. Standard junction box mounting.
b. Quick low voltage connections using standard RJ-45 patch cables.
c. Manual override and pilot indication for each load.
d. Universal voltage (120 – 277 VAC).
e. Zero cross circuitry.
f. Low power consumption, 150 ma switched power supply for sensors and switches.
g. Three RJ-45 DLM local network ports.
h. Watt Stopper product numbers: LMRC-212 / LMRC-213.
i. Enhanced Room Controllers shall include all the features of the Room Controller plus the following enhancements:
j. One, two or three relay configuration.
k. 250 ma switched power supply.
l. Four RJ-45 DLM local network ports.
m. One zero to 10 volt analog output per relay for control of dimmable ballasts.
n. Optional BACnet MS/TP communications port.
o. Current monitoring.
p. Plug Load Room Controllers provide dedicated control of plug loads within the space. The controllers plug into the DLM local network using the RJ-45 free topology network. The room controllers include the following features.
q. One relay configuration only.
r. Automatic ON/OFF configuration based upon room occupancy.
s. Default 30 minute (adjustable) additional time delay from lighting shut off to allow for electronic component use after an area is vacant.
t. Watt Stopper product number: LMPL-101.

2.6 DIGITAL PHOTOSENSORS

A. Provide automatic daylight harvesting capabilities to the Room Controllers. The photo sensor / room controller configuration automatically configures the daylighting set points for ON/OFF or Dimming control. Using the automatic configuration replacing a photo sensor or room controller can be done without any special tools, programming or configuration. Photosensors include the following features:

1. The digital photosensor shall utilize an internal photodiode that measures light in a 100 degree angle cutting the unwanted light from bright sources outside of this cone
2. The digital photosensor shall be capable of turning lighting on and off or Raise / Lower depending on the binding to the Room Controller. Sensor range shall be from 1 - 1400fc.
3. For ON/OFF daylight harvesting the controller provides a “hold on while occupied” feature that prohibits high levels from turning OFF the controlled lights as long as the space remains occupied.
4. The sensor has a threaded nipple that mounts on a ceiling tile and for more challenging applications such as a side wall or hard rock ceiling the nipple pops off and the unit can be screwed down

B. Watt Stopper Product Numbers: LMLS-400, LMLS-500, LMLS-600.

2.7 ROOM NETWORK

A. The DLM local network is a free topology lighting control network and protocol designed to control a small area of a building. Digital room devices connect to the network using RJ-45 patch cords which provide both data and power to the sensors and switches. Features of the DLM local network include

1. Automatic configuration and binding of sensors, switches and lighting loads to the most energy efficient sequence of operation based upon the device attached.
2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
3. Push and Learn configuration that can change the automatic binding process and load parameters by using only the digital devices in the room.
4. Two way infrared communications that allow load parameters, sensor configuration and binding operations to be configured through a hand held configuration tool up to 30 feet from any device

B. Support for the following devices within a room:

1. 64 loads within the room
2. 64 switches
3. 6 occupancy sensors
4. Maximum of 800 milliamps of power for sensors, switches and auxiliary devices.

2.8 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is resotred. Features include

1. 120 - 277 volts, 50/60 Hz, 20 amp ballast rating
2. Push to test button
3. Auxiliary contract for test / Fire Alarm system

PART 3 - EXECUTION

3.1 INSTALLATION

A. When using wire other than RJ-45 connections provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements

B. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.

C. Calibrate all sensor time delays and sensitivity to guarantee proper coverage of occupants and energy savings.

1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.

D. Provide written or computer generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, daylighting set points.
2. Sequence of operation, manual ON, Auto OFF, etc.
3. Load Parameters - blink warning, etc.

E. Re-commissioning – After 30 days from occupancy re-calibrate all sensors time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

F. Spare Parts – Provide to Owner ten (10) spare units of each device and cable used in this system.

END OF SECTION 260923

SECTION 262213 - LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general-purpose and specialty dry-type transformers and voltage regulators with windings rated 600 V or less.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each product specified, including dimensioned plans, sections, and elevations. Show minimum clearances and installed features and devices. Include rated KVA, primary and secondary voltage, and all taps.

C. Wiring diagrams of products differentiating between manufacturer-installed and field-installed wiring.

D. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include a list of relevant completed projects with project names and addresses, and names and addresses of the respective Architects and Owners.

F. Certified Test Reports, including: No load losses, full load losses, Sound level, average temperature rise above 40^{o} ambient, attenuation and field strength for K-rated transformers.

G. Product Test Reports: Certified copies of manufacturer's routine factory tests required by the referenced standards.

H. Sound Level Test Reports: Certified copies of manufacturer's sound level tests applicable to equipment for this Project.

I. Operation and maintenance data for materials and products to include in the "Operating and Maintenance Manual" specified in Division 1.

J. Field test reports of tests and inspections conducted according to Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing components that comply with the requirements of these Specifications and that have a record of successful in-service performance.

B. Field-Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.

C. Comply with NFPA 70, National Electrical Code.

D. Comply with IEEE C2, National Electrical Safety Code.

E. Listing and Labeling: Products are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's recommendations within the enclosure of each ventilated type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

B. Protection: Cover transformer ventilating openings to keep out dust.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Existing Electrical distribution Equipment at this facility is Square D. Subject to compliance with requirements, provide products by the following:

1. Transformers:
   a. Square D Co.
   b. Acme Electric Corporation.
   c. Controlled Power Company; an Emerson company.
   d. Dongan Electric Manufacturing Company.
   e. Eaton.
   f. Federal Pacific.
   g. General Electric Company.
   h. Hammond Power Solutions Inc.
   i. Jefferson Electric, Inc.
   j. Lincoln Electric Products Co., Inc.
   k. Mag-Tran; a division of Quality Transformer & Electronics.
   l. Marcus Transformer LTD.
   m. MGM Transformer Company.
   n. Micron Industries Corporation.
   o. Mirus International Inc.

2.2 TRANSFORMERS, GENERAL

A. Transformers: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, nonaging silicon steel.

C. Coils: Continuous windings without splices except for taps.

D. Internal Coil Connections: Brazed or welded type. Enclosure temperature not to exceed 50° C rise above 40° C ambient.

2.3 GENERAL-PURPOSE, DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20, Dry-Type Transformers for General Applications.

B. Transformers: Two-winding type, 3-phase units using 1 coil per phase in primary and secondary.

C. Windings: Copper or Aluminum.

D. Low Sound Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE Standard C57.12.91, Test Code for Dry-Type Distribution and Power Transformers.

E. Features and Ratings: As follows:

1. Enclosure: Indoor, ventilated.
2. Enclosure: Outdoor, ventilated, raintight, NEMA 3R.

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

G. Taps: For transformers 3 kVA and larger, full capacity taps in high-voltage winding are as follows:

1. 3 kVA through 10 kVA: Two 5-percent taps below rated high voltage.
2. 15 kVA through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
3. 750 kVA and Above: Four 2.5-percent taps, 2 above and 2 below rated high voltage.

H. Accessories: The following accessory items are required where indicated:

1. Surge Arresters: NEMA Standard LA 1, low-voltage type, factory installed and connected to high-voltage terminals.
2. Surge Arresters: NEMA Standard LA 1, low-voltage type, factory installed and connected to low-voltage terminals.
3. Electrostatic Shielding: Insulated metallic shield between primary and secondary windings.

a. Connect shield to terminal marked "Shield" for grounding connection.
b. Capacitance: Arrange shield to provide a maximum of 33 picofarads primary-to-secondary capacitance over a frequency range of 20 Hz to 1 MHz.

4. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.

2.4 TRANSFORMERS, NON-LINEAR LOADS

A. Meet all requirements of General-Purpose, Dry Type Transformers.

B. K-Rating as shown on drawings and UL listed for k-factor rating.

C. Neutral terminal rated 200% of phase current.

2.5 CONTROL AND SIGNAL TRANSFORMERS

A. Comply with NEMA Standard ST 1, Specialty Transformers, and UL Standard 506, Specialty Transformers.

B. Ratings: Continuous duty. Where ratings is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Type: Self-cooled, 2-winding, dry type.

D. Enclosure: Suitable for the location where installed.

2.6 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. Outdoor Units: Comply with Enclosure Coating System Article of IEEE Standard C57.12.28 Pad-Mounted Equipment Enclosure Integrity.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests conform to referenced standards.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project where specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arrange equipment to provide adequate spacing for access and for cooling air circulation. Not less than 3 inches behind transformers less than 45 kVA, and not less than 12 inches behind transformers larger than 45 kVA.

B. Identify transformers and install warning signs according to Division 26, Section 26 0553, Identification for Electrical Systems.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified in UL 486A and UL 486B.

D. Provide concrete housekeeping pads for all floor mounted transformers.

3.2 GROUNDING

A. Ground transformers and systems served by transformers according to Division 26, Section 26 0526, Grounding and Bonding for Electrical Systems.

B. Core visibly grounded to enclosure by a flexible grounding conductor.

3.3 FIELD QUALITY CONTROL

A. Test Objectives: To ensure transformer installation is operational within industry and manufacturer's tolerances, install according to Contract Documents, and suitable for energizing.

B. Test Labeling: Upon satisfactory completion of tests for each unit, attach a dated and signed "Satisfactory Test" label to the tested component.

C. Schedule tests and provide notification at least one week in advance of test commencement.

D. Report: Submit a written report of observations and tests. Report defective materials and workmanship.

E. Tests: Include the following minimum inspections and tests according to the manufacturer's instructions. Conform to IEEE Standard Test Code C57.12.91 for dry-type units, test method, and data correction factors.

1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.

    a. Include internal inspection through access panels and covers.
    b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of UL Standards 486A and 486B.

2. Insulation Resistance: Perform megohmmeter test of primary and secondary winding-to-winding and winding-to-ground. Use a minimum test voltage of 1,000 V d.c. Minimum insulation resistance is 500 megohms.
3. Duration of Each Test: 10 minutes.
4. Temperature Correction: Correct results for test temperature deviation from 20^{o}C standard.

5. Testing for Voltage Regulators: Perform same tests and inspections specified above for transformers. Include functional test throughout operating range of device. Check voltage tolerance, correction speed, and harmonic content of output for stepped changes in source voltage at 35 percent, 70 percent, and 100 percent of rated load.

F. Test Failures: Correct deficiencies identified by tests and retest. Verify that equipment meets the specified requirements.

3.4 ADJUSTING

A. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

C. Adjust buck-boost transformer connections to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility.

D. Adjust voltage regulators to provide optimum voltage at equipment served throughout the normal operating cycle of the facility. Record adjustment settings to submit with test results.

3.5 DEMONSTRATION

A. Adjustment and Training: Arrange and pay for factory-authorized service representatives to adjust and demonstrate voltage regulators and to conduct related training for Owner's maintenance personnel. Provide a minimum of four (4) hours of training that include the following:

1. Safety precautions.
2. Features and construction of project equipment.
3. Voltage adjustment procedures.
4. Routine inspection and test procedures.
5. Routine cleaning.
6. Interpretation of readings of indicating and alarm devices.

B. Schedule training with at least seven (7) days advance notice.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V and less.

B. Related Sections include the following:

1. Division 26, Section 26 0500, Common Work Results for Electrical for general and installation materials and methods.
2. Division 26, Section 26 0553, Identification for Electrical Systems for identification materials.
3. Division 26, Section 26 4313 Surge Protection Devices for Low-Voltage Electrical Power Circuits.

1.3 SUBMITTALS

A. Product Data: For each product and component specified.

B. Shop Drawings: For each switchboard. Show dimensioned plans and elevations, including required clearances and service space, component and device lists, and a single-line diagram showing main- and branch-bus current ratings and short-time and short-circuit ratings of switchboard. Include the following:

1. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
2. Utility company metering provisions with indication of approval by utility company.
3. Bus configuration, current rating, voltage rating, and short circuit rating of overcurrent devices.
4. Schedule of features, characteristics, ratings, and factory settings of individual protective devices.
5. Wiring Diagrams: Details of wiring for power and control and differentiating between manufacturer-installed and field-installed wiring.
6. Nameplate Schedule.
7. Cable terminal sizes.
8. Key interlock scheme drawing and sequence of operation.
9. Seismic Certification.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Reports of Field Tests and Observations: Certified by testing agency.

E. Manufacturer field service report.

F. Certificates for field testing agency, signed by Contractor, certifying that agency complies with requirements specified in "Quality Assurance" Article below.

G. Maintenance Data: For switchboards to include in the maintenance manuals specified in Division 1. Include detailed manufacturer's written instructions on adjusting overcurrent protective devices.

1. Routine maintenance requirements.
2. Time current curves, including selectable range, for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section Quality Control, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full-member company of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide switchboard assemblies specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

C. Comply with NFPA 70.

D. Comply with NEMA PB 2.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboard equipment, including clearances between switchboard and adjacent surfaces and items. Switchboards having equal performance characteristics and complying with indicated maximum dimensions may be considered.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.

B. Store so condensation will not occur on or in switchboards. Provide temporary heaters as required to avoid condensation.

C. Handle switchboards according to NEMA PB 2.1. Use only factory-installed lifting provisions.

1.6 PROJECT CONDITIONS

A. Verify dimensions by field measurements.

B. Determine suitable path for moving switchboard into place considering Project conditions.

C. Verify clearance requirements. Locate switchboard to meet installation tolerances.

D. Revise locations and elevations from those indicated as required to suit Project conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Existing Electrical distribution at this facility is Square D. Subject to compliance with requirements, provide products by the following:

1. Square D Co.
2. Siemens
3. Eaton
4. G.E.

2.2 MANUFACTURED UNITS

A. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.

1. Main Device: Individually fixed mounted.
2. Branch Devices: Panel mounted.

B. Ratings: Provide nominal system voltage, continuous main-bus amperage, and short-circuit current ratings as indicated.

C. Nominal System Voltage: Refer to drawings.

D. Main-Bus Continuous: Refer to drawings.

E. Service Entrance: Suitable for use as service entrance equipment and so labeled in accordance with UL requirements.

2.3 FABRICATION AND FEATURES

A. Enclosure: Steel; NEMA 250, Type 1, or as indicated on Contract Drawings.

B. Bus Transition and Incoming Line Pull Sections: Matched and aligned with basic switchboard.

C. Removable, Hinged Rear Covers: Secured by captive thumb screws, for access to rear interior of switchboard.

D. Hinged Front Panels: Allow access to breaker, metering, accessory, and blank compartments.

E. Buses and Connections: 3 phase, 4 wire, except as otherwise indicated. Features as follows:

1. Phase and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections. Use copper for feeder circuit-breaker line connections.
2. Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
3. Ground Bus: 1/4-by-2-inch minimum size, drawn-temper copper of 98 percent conductivity; equipped with pressure connectors for feeder- and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Contact Surfaces of Buses: Silver plated.
5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from both ends.
6. Isolation Barrier Access Provisions: Permit checking bus bolt tightness.
7. Neutral Buses: 100 percent of the ampacity of the phase buses, except as indicated, and equipped with approved pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus is braced.
8. Aluminum is not permitted.

F. Bus-Bar Insulation: Not required.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.

1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
2. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
3. Circuit Breakers 400A and Larger: Field-adjustable short-time and continuous current setting unless noted otherwise on plans.
4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
6. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
7. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
8. Shunt Trip: Where indicated.

B. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased power circuit breaker.
1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.

2. Features: Include the following:

   a. Drawout circuit-breaker mounting.
   b. 2-step stored-energy closing.
   c. Microprocessor-based trip units with interchangeable rating plug and selectable I-squared-t response.
   d. LED trip indicators.
   e. Remote trip indication and control
   f. Undervoltage trip.
   g. Shunt trip.

3. Control Voltage: 48 V, ac.
4. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

C. Future Devices: Where indicated, equip compartments with mounting brackets, supports, bus connections, and appurtenances designed for overcurrent protective device types and ampere ratings indicated.

2.5 OTHER CIRCUIT CONTROL AND PROTECTIVE DEVICES

A. Factory-installed and factory-tested devices of types listed below, with indicated ratings, settings, and features.

B. Surge Protective Devices: IEEE C62.41, selected to meet requirements for category indicated.

1. Exposure: Medium.

C. Impulse sparkover voltage coordinated with system circuit voltage.

D. Factory mounted with UL-recognized mounting device.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

2.7 IDENTIFICATION

A. Nameplates and label products are specified in Division 26, Section 26 0500, Common Work Results for Electrical.

B. Nameplates and label products are specified in Division 26, Section 26 0553, Identification for Electrical Systems.

1. Compartment Nameplates: Engraved laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchboard for compliance with installation tolerances and other conditions affecting performance of switchboards.

1. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards level and plumb as indicated, according to manufacturer's written instructions and NEMA PB 2.1.

B. Support switchboards on concrete housekeeping bases, 4-inch nominal thickness. Bases to be 4 inches larger in both directions than overall dimensions of supported unit.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Anchor: Anchor switchboards in accordance with Manufacturer’s recommendations and to meet UBC Seismic Zone requirements. (See Division 1 specifications for more information.)

E. Operating Instructions: Frame and mount printed, basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on the front of switchboards.

3.3 CONNECTIONS

A. Connect switchboards and components to wiring systems and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26, Section 26 0500, Common Work Results for Electrical.
B. Install compartment nameplates.

3.5 FIELD QUALITY CONTROL

A. Standards: Comply with applicable standards of the InterNational Electrical Testing Association (NETA), including standard ATS.

B. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each switchboard bus, component, and connecting supply, feeder, and control circuits. Insulation resistance less than 100 megohms is not acceptable.
2. Make continuity tests of each circuit.

C. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise pretesting and adjustment of switchboard components for a total of not less than five (5) working days.

D. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of each switchboard. Remove fronts to make joints and connections accessible to a portable scanner.

1. Reference specification section 260880 for testing requirements.
2. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
3. Record of Infrared Scanning: Prepare a certified report identifying switchboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 CLEANING

A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below:

1. To identify each switchboard location.
2. To instruct in function, operation, and maintenance of each component.
3. To instruct in each distinct procedure and schedule related to servicing and preventive maintenance.
4. Schedule training with at least seven (7) days advanced notice.

B. Training: Conduct a minimum of one full day of training, including both classroom and hands-on equipment training.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.

B. Related Sections include the following:

1. Division 26, Section 26 0500, Basic Electrical Materials and Methods for general materials and installation methods.
2. Division 26, Section 26 0553, Identification for Electrical Systems for labeling materials.
3. Division 26, Section 26 2813, Fuses.
4. Division 26, Section 26 4313 Surge Protection Devices for Low-Voltage Electrical Power Circuits.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, accessory item, and component specified.

B. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type with details for types other than NEMA 250, Type 1.
2. Bus configuration and current ratings.
3. Short-circuit current rating of panelboard.
4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
5. Wiring Diagrams: Details of schematic diagram including control wiring and differentiating between manufacturer-installed and field-installed wiring.

C. Electronic Grade Panelboards: Submit the following additional information:

1. Documentation: Provide data showing the following:

a. UL Listing: UL 67 and UL 1283.
b. Clamping Voltage: UL 1449 Rating.
c. Factory Tests: Procedure and reports. Tested to meet ANSI/IEEE C62.41, tested per ANSI/IEEE C62.45.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 1. Include manufacturer's written instructions for testing circuit breakers.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control," a testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

C. Comply with NFPA 70 and NEMA PB 1.

1.5 EXTRA MATERIALS

A. Keys: 6 spares of each type for panelboard cabinet lock. All locks shall be keyed alike.

B. Touch-Up Paint: One half pint container for enclosures and fronts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Existing Electrical distribution at this facility is Square D. Subject to compliance with requirements, provide products by the following:

1. Panelboards:

a. Square D Co.
b. Siemens
c. Eaton
d. G.E.

2.2 PANELBOARD FABRICATION

A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 1.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

B. Directory Frame: Metal, mounted inside each panelboard door.

C. Bus: Hard drawn copper of 98 percent conductivity. Aluminum is not permitted.

D. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.

E. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

F. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.

G. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.

H. Special Features: Include the following features for panelboards as indicated:

1. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover. The door over the interior of the panel shall be provided with hinge and combination lock and latch. The outside door over the panel gutters shall have a hinge on one side and combination lock and latches. All locks shall be keyed alike. Front for surface mounted panelboards shall be same dimensions as box. Fronts for flush paneboards shall overlap box, unless otherwise indicated. Required for NEMA 1 panelboards unless otherwise indicated.
2. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
3. Split Bus: Vertical bus of indicated panelboards divided into 2 vertical sections with connections as indicated.
4. 200% Neutral: Copper, rated 200% of phase bus, and UL listed as suitable for non-linear loads.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and floor.

I. Feed-through Lugs: Mechanical type sized to accommodate feeders indicated.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series connect short-circuit rating.

B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

C. Panelboards shall have a minimum AIC rating as indicated on the drawings based on the short circuit study.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Door-in-door in panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

2.5 DISTRIBUTION PANELBOARDS

A. Doors: In panelboard front, except omit in fusible-switch panelboard, unless otherwise indicated. Secure door with vault-type latch with tumbler lock, all keyed alike.

B. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1 / UL 489.

1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
6. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
7. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
8. Shunt Trip: Where indicated.
9. Handle Lockable: Where indicated.

2.7 SURGE PROTECTION DEVICES / TRANSIENT VOLTAGE SURGE SUPPRESSORS

A. See Division 26, Section 26 4313 Surge Protection Devices for Low-Voltage Electrical Power Circuits.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Directory to reference permanent room numbering in lieu of room numbering shown on the drawings. Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

H. Labels for identifying the breakers shall be engraved laminated plastic strips attached by screws or Phenolic buttons or small window frame type. Adhesive stick-on labels will not be acceptable.

3.2 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26, Section 26 0553, Identification for Electrical Systems.

B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

3.3 GROUNDING

A. Make equipment grounding connections for panelboards or main electrical ground bus as indicated.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:

1. Perform measurements during period of normal working load as advised by Owner.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

B. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of each panelboard. Remove fronts to make joints and connections accessible to a portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scanning of each panelboard 11 months after date of Substantial Completion.
2. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
3. Record of Infrared Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes various types of receptacles, connectors, switches, and finish plates.

1.3 SUBMITTALS

A. Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each product specified, including all information required to show compliance with all requirements.

C. Shop Drawings: Legends for receptacles and switch plates.

D. Samples of devices, device plates, and telephone/power service poles for color selection and evaluation of technical features.

E. Operation and maintenance data for materials and products specified in this Section to include in the "Operating and Maintenance Manual" specified in Division 1.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, National Electrical Code for devices and installation.

B. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.5 COORDINATION

A. Wiring Devices for Owner Furnished Equipment: Match devices to plug connectors for Owner-furnished equipment.

B. Cord and Plug Sets: Match cord and plug sets to equipment requirements.

1.6 EXTRA MATERIALS

A. Furnish the following extra materials, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Owner.

1. Telephone/Power Service Poles: 1 for each 10, but not less than 1.
2. Floor Service Outlet Assemblies: 1 for each 10, but not less than 1.
3. Poke-Through Fire-Rated Closure Plugs: 1 for each 5 floor service outlets installed, but not less than 2.
4. Transient-Voltage Surge-Suppressor Receptacles: 1 for each 8 installed, but not less than 2.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices:

a. Arrow Hart Div., Cooper Industries
b. Bryant Electric, Inc.
c. Eagle Electric Mfg. Co., Inc.
d. General Electric Co.
e. Hubbell Inc.
f. Leviton Mfg. Co., Inc.
g. Pass & Seymour/Legrand

2. Wiring Devices for Hazardous (Classified) Locations:

a. Crouse-Hinds Electrical Construction
b. Killark Electrical Mfg. Co.
c. Pyle-National Co.

3. Multi-Outlet Assemblies:

a. Airey-Thompson Co., Inc.
b. Dual-Lite
c. Isoduct Energy Systems
d. Kellems Div., Hubbell, Inc.
e. Wiremold Co.

4. Poke-Through, Floor Service Outlets, and Telephone/Power Poles:

a. American Electric
b. Hubbell, Inc.
c. Pass & Seymour/LeGrand
d. Square D Co.
e. Walker Div., Butler Mfg. Co.
f. Wiremold Co.

2.2 WIRING DEVICES

A. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices."

B. Enclosures: NEMA 1 equivalent, except as otherwise indicated.

C. Color: By Architect except as otherwise indicated or required by Code.

D. Receptacles, Straight-Blade and Locking Type: Except as otherwise indicated, comply with Federal Specification W-C-596 and heavy-duty grade of UL Standard 498, "Electrical Attachment Plugs and Receptacles." Provide NRTL labeling of devices to verify these compliances. 20A unless noted otherwise.

E. Receptacles, Straight-Blade, Hospital Grade: Listed and labeled for compliance with Hospital Grade of UL Standard 498, "Electrical Attachment Plug and Receptacle," and Federal Specification W-C-598. 20A unless noted otherwise.

F. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicted, and with the following additional requirements:

1. Ground-Fault Circuit Interrupter (GFCI) Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed-through type, with integral NEMA 5-20R duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Design units for installation in a 2-3/4-inch deep outlet box without an adapter.
2. Isolated Ground Receptacles: Equipment grounding contacts are connected only to the green grounding screw terminal of the device and have inherent electrical isolation from the mounting strap.

    a. Devices: Listed and labeled as isolated ground receptacles.
    b. Isolation Method: Integral to the receptacle construction and not dependent on removable parts.

3. Transient-Voltage Surge-Suppressor (TVSS) Receptacles: Duplex type, NEMA 5-20R configuration, with integral transient-voltage surge protection in a minimum of 3 modes: line-to-ground, line-to-neutral, and neutral-to-ground; listed as complying with UL Standard 1449 "Transient Voltage Surge Suppressors."

    a. Surge Protection Components: Multiple metal-oxide varistors, rated for 500 V transient suppression voltage nominal clamp level and minimum single transient pulse energy dissipation of 140 J, line-to-neutral, and 70 J, line-to-ground and neutral-to-ground.
    b. Active Protection Indication: A light visible in the face of the device indicates the state of the device as "active" or "no longer active."
    c. Identification: Distinctive marking on face of device denotes transient-voltage surge-suppressor type unit.

G. Receptacles, Industrial Heavy-Duty: Conform to NEMA Standard PK 4 "Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use."

H. Receptacles in Hazardous (Classified) Locations: Comply with NEMA Standard FB 11 "Plugs,

Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations" and UL Standard 1010 "Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations."

I. Pendant Cord/Connector Devices: Matching, locking type, plug and plug receptacle body connector, NEMA L5-20P and L5-20R, heavy-duty grade.

1. Bodies: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire mesh type made of high-strength galvanized-steel wire strand and matched to cable diameter and with attachment provision designed for the corresponding connector.

J. Cord and Plug Sets: Match voltage and current ratings and number of conductors to requirements of the equipment being connected.

1. Cord: Rubber-insulated, stranded copper conductors, with type SOW-A jacket. Grounding conductor has green insulation. Ampacity is equipment rating plus 30 percent minimum.
2. Plug: Male configuration with nylon body and integral cable-clamping jaws. Match to cord and to receptacle type intended for connection.

K. Snap Switches: Quiet-type a.c. switches, NRTL listed and labeled as complying with UL Standard 20 "General Use Snap Switches," and with Federal Specification W-S-896. Specification Grade 20A, 120-277V.

L. Snap Switches in Hazardous (Classified) Locations: Comply with UL Standard 894, "Switches for Use in Hazardous (Classified) Locations."

M. Dimmer Switches: Modular full-wave solid-state units with integral, quiet on-off switches, and audible and electromagnetic noise filters.

1. Wattage rating exceeds connected load by 30 percent minimum, except as otherwise indicated.
2. Control: Continuously adjustable slide OR toggle. Single-pole or 3-way switch to suit connections.
3. Incandescent Lamp Dimmers: Modular dimmer switches for incandescent fixtures; switch poles and wattage as otherwise indicated, 120 V, 60 Hz with continuously adjustable, toggle, or slide, single-pole with soft tap or other quiet switch. Equip with electromagnetic filter to eliminate noise, RF and TV interference, and 5-inch wire connecting leads. As manufactured by Lutron Nova.
4. Fluorescent Lamp Dimmers: Modular dimmer switches compatible with dimmer ballasts. Trim potentiometer adjusts low-end dimming. Dimmer-ballast combination is capable of consistent dimming to a maximum of 10 percent of full brightness. As manufactured by Lutron Nova.

N. Weatherproof Receptacles: Duplex receptacles, comply with basic requirements above. Cast metal box, cover plate, and cover to provide weatherproof capability with plugs and cords installed.

O. Wall Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:

1. Color: Matches wiring device except as otherwise indicated.

2. Plate-Securing Screws: Metal with heads colored to match plate finish.
3. Material for Unfinished Spaces: Galvanized steel.

2.3 FLOOR SERVICE OUTLET ASSEMBLIES

A. Types: Modular, above-floor, dual-service units suitable for the wiring method used.

B. Compartmentation: Barrier separates power and signal compartments.

C. Housing Material: Die-cast aluminum, satin finished.

D. Power Receptacle: NEMA configuration 5-20R, gray finish, except as otherwise indicated.

E. Signal Outlet: Blank cover with bushed cable opening, except as otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

D. Protect devices and assemblies during painting.

E. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit the indicated arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26, Section 26 0553, Identification for Electrical Systems.

1. Switches: Where 3 or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved on wall plate.
2. Receptacles: Identify the panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on both faces of plate (front and rear) and durable wire markers or tags within outlet boxes.

3.3 GROUNDING

A. Isolated Ground Receptacles: Connect to isolated grounding conductor routed to designated isolated equipment ground terminal of electrical system.

B. Equipment Ground: Connect to device and to box.

3.4 FIELD QUALITY CONTROL

A. Testing: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.

B. Check TVSS receptacle indicating lights for normal indication.

C. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer recommendations.

D. Replace damaged or defective components.

3.5 CLEANING

A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices. Replace wall plates or devices marked with pencil, pen, or other non-standard marking system. Thoroughly clean all device plates, remove fingerprints, smudges, and dirt.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Fuses.
2. Spare fuse cabinet.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each fuse type specified. Include the following:

1. Descriptive data and time-current curves.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Coordination charts and tables and related data.
4. Fuse size for elevator feeder and disconnect applications.

C. Field test reports indicating and interpreting test results.

D. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses 0-2000 amperes: Furnish quantity equal to 10 percent of each fuse type and size installed, but not less than 1 set of 3 of each type and size.
2. Spare Fuses 2001-6000 amperes: One (1) set of three (3) of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide fuses by one of the following:

1. Cooper Industries, Inc.; Bussmann Div.
2. General Electric Co.; Wiring Devices Div.
3. Gould Shawmut
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

1. Manufacturer: All fuses to be of same manufacturer.
2. Color: Distinctive and easily identifiable.
3. Listing: UL Listed for application.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door with key-coded cam lock and pull.

1. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: Stencil legend "SPARE FUSES" in 1-1/2-inch letters on door.
4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Main Service 601-6000 ampere: Class L, time delay.

B. Main Feeders 0-600 ampere: Class J, time delay.

C. Motor Branch Circuits: Class J, time delay.

D. Other Branch Circuits: Class J, time delay.

E. Control Transformers and Control Circuits: Class CC or Class J, time delay.

F. Fluorescent and H.I.D. Ballasts: Over 300 volts, Class CC or Class J, time delay.

G. DC Circuits: Less than 500 volts, 0-600A Class J, time delay; 601-6000A Class L, time delay.

H. Existing Installations: As above, or RK1 time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

B. Install spare fuse cabinet where indicated.

C. Torque mounting bolts to ASTM recommendations.

D. Bolted in place fuses to have "Belleville" washers between each bolt head or nut and fuse blade.

3.4 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes individually mounted switches and circuit breakers used for the following:

1. Service disconnect switches.
2. Feeder and equipment disconnect switches.
3. Feeder branch-circuit protection.
4. Motor disconnect switches.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26, Section 26 2726, Wiring Devices, for attachment plugs and receptacles, and snap switches used for disconnect switches.
2. Division 26, Section 26 2413, Switchboards, for individually enclosed, fused power-circuit devices used as feeder disconnect switches.
3. Division 26, Section 26 2813, Fuses, for fuses in fusible disconnect switches.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for switches, circuit breakers, and accessories specified in this Section. Include the following

1. Descriptive data, time-current curves, and short circuit interrupting capacity.
2. Let-through current curves for circuit breakers with current-limiting characteristics.
3. Coordination charts and tables and related data.

C. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Field test reports indicating and interpreting test results.

F. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide disconnect switches and circuit breakers by one of the following:

1. Fusible Switches:

a. Eaton Corp.; Cutler-Hammer Products
b. General Electric Co.; Electrical Distribution and Control Division
c. General Switch Corp.
d. Siemens Energy & Automation, Inc.
e. Square D Co.

2. Molded-Case Circuit Breakers:

a. Eaton Corp.; Cutler-Hammer Products
b. General Electric Co.; Electrical Distribution and Control Division
c. General Switch Corp.
d. Siemens Energy & Automation, Inc.
e. Square D Co.

3. Combination Circuit Breaker and Ground Fault Trip:

a. American Circuit Breaker Corp.
b. General Electric Co.; Electrical Distribution and Control Division
c. Siemens Energy & Automation, Inc.
d. Square D Co.

4. Molded-Case, Current-Limiting Circuit Breakers:

a. General Electric Co.; Electrical Distribution and Control Division

b. Siemens Energy & Automation, Inc.
c. Square D Co.
d. Westinghouse Electric Corp.; Distribution & Control Business Unit

5. Integrally Fused, Molded-Case Circuit Breakers:

a. General Electric Co.; Electrical Distribution and Control Division
b. Siemens Energy & Automation, Inc.
c. Westinghouse Electric Corp.; Distribution & Control Business Unit

2.2 DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD with lockable handle.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.

C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3
2. Kitchen Areas: Type 1 unless otherwise indicated on Plans.
3. Other Wet or Damp Indoor Locations: Type 3

2.3 CIRCUIT BREAKERS

A. Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.

Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.

B. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.

C. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

D. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous current settings.

E. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.

F. Current Limiters: Where indicated, integral fuse listed for circuit breaker.

G. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.

H. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

I. Shunt Trip: Where indicated.

J. Accessories: As indicated.

K. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3.
2. Other Wet or Damp Indoor Locations: Type 3

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb.

C. Install wiring between disconnect switches, circuit breakers, control, and indication devices.

D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Identify each disconnect switch and circuit breaker according to requirements specified in Division 26, Section 26 0553, Identification for Electrical Systems.

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 ADJUSTING

A. Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 262816

SECTION 262820 - GROUND-FAULT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplemental General Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

A. This section includes ground-fault sensing, relaying, tripping, and monitoring devices for installation in distribution switchboards and panelboards rated 600 V and less.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each component specified.

C. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Field test reports indicating and interpreting test results relative to compliance with performance requirements of ground-fault protection system.

F. Maintenance data for ground-fault relay to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer to install ground-fault protection system components that is acceptable to manufacturer of switchboard or disconnect device in which installation is to be made.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing ground-fault protection components similar to those indicated for this Project and with a record of successful in-service performance.

C. Testing Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the InterNational Electrical

Testing Association (NETA).

1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Comply with UL 1053.

E. Comply with NFPA 70.

F. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering ground-fault protection components that may be incorporated into the Work include, but are not limited to, the following:

1. Schneider Electric; Square D Group

2.2 GROUND-FAULT SENSING DEVICES

A. Current Sensors: Round- or split-core rectangular current transformers.

B. Short-Circuit Rating: 200,000 symmetrical amperes.

C. Sensor Outputs: Compatible with relay inputs.

D. Split-Core Construction: Rectangular sensors are constructed to allow installation and removal without disturbing electrical conductors being encircled.

E. Relay Test Provisions: Test winding in sensor is arranged to permit testing the operation of complete ground-fault protection system, including sensor, relay, monitor panel, and circuit-interrupting device.

2.3 RELAYS AND MONITORS

A. Ground-Fault Relay: Solid-state type that requires no external source of electrical power for relay operation.

1. Testing and Tripping Voltage: 120 VAC, from external source.
2. Interlocking: Field wiring terminals and interface devices accommodate zone-selective coordination with other ground-fault relays or with ground-fault function of electronic

trip units of circuit breakers indicated for coordination.

3. Pick-up Current Sensitivity: Field adjustable from 100 to 1200 A, with calibrated dial designed to inhibit tampering with setting.
4. Time Delay: Field adjustable from instantaneous to one second, with calibrated dial designed to inhibit tampering with setting.
5. UL 1053, Class I.
6. Output Circuit: Compatible with rating of tripping coils of interrupting device.
7. Zone-Selective Coordination Capability: Designed to coordinate with other ground-fault protection and with electronic trip units of circuit breakers indicated for coordination.

B. Monitor Panels: Include ground-fault indicator, control-power indicator, and test and reset buttons, arranged to allow testing with and without tripping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment to receive ground-fault protection devices for compliance with installation tolerances and other conditions affecting integrity and safety of completed installation and performance of the ground-fault protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install ground-fault protection devices according to manufacturer's written instructions.

B. Install sensors so they encircle power-conductor bus bars or cables symmetrically.

Maintain clearances between conductors and sensor body as recommended by device manufacturer.

C. Fasten and support sensors without mechanical stress, twisting, or misalignment being exerted by clamps, supports, bus bars, or cables.

D. Install interconnecting wiring for zone-selective systems in raceway where it runs external to component enclosure. Comply with Division 26 Sections, Raceways and Boxes and Wires and Cables.

E. Connections: Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.3 FIELD QUALITY CONTROL

A. Testing: Upon completion of installation of ground-fault protection system and after electrical circuits have been energized, demonstrate capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.14. Certify compliance with test parameters.

B. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.4 ADJUSTING

A. Perform short-circuit analysis and coordination study. Set field-adjustable pick-up and time-sensitivity values accordingly.

B. Coordination: Use zone-selective method with 0.1-second delay of upstream devices between upstream and downstream ground-fault protection devices and circuit-breaker electronic trip units.

END OF SECTION 262820

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ac motor-control devices rated 600 V and less that are supplied as enclosed units.

B. Related Sections include the following:

1. Division 26, Section 26 0553, Identification for Electrical Systems for labeling materials.
2. Division 26, Section 26 2813, Fuses.
3. Division 26, Section 26 4313, Transient Voltage Suppression for Low Voltage Electrical Power
Circuits.

1.3 SUBMITTALS

A. Product Data: For products specified in this Section, include catalog data, dimensions, ratings, data on features and components, and wiring diagrams.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Maintenance Data: For products to include in the maintenance manuals specified in Division 1.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Qualification Data for Field Testing Agency: Certificates, signed by Contractor, certifying that agency complies with requirements specified in "Quality Assurance" Article below.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain similar motor-control devices through one source from a single manufacturer.

C. Comply with NFPA 70.

D. Listing and Labeling: Provide motor controllers specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.5 COORDINATION

A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, and the duty cycle of the motor and load.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses and Incandescent Indicating Lamps: Furnish 1 spare for every 5 installed units, but not less than 1 set of 3 of each kind.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary
2. Allen-Bradley Co.; Industrial Control Group
3. Crouse-Hinds ECM.; Cooper Industries, Inc. Div.
4. Danfoss Inc.; Danfoss Electronic Drives Div.
5. Eaton Corp.; Westinghouse & Cutler-Hammer Products
6. Furnas Electric Co.
7. General Electric Co.; Electrical Distribution & Control Div.
8. Siemens Energy & Automation, Inc.
9. Square D Co.

2.2 MANUAL MOTOR CONTROLLERS

A. Description: NEMA ICS 2, general purpose, Class A with toggle action and overload element. Include red pilot light.

2.3 MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

B. Control Circuit: 120 V; obtained from integral control power transformer, unless otherwise indicated. Include a control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

C. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses indicated. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a Nationally Recognized Testing Laboratory.
2. Nonfusible Disconnect: NEMA KS 1, heavy-duty, nonfusible switch.
3. Circuit-Breaker Disconnect: NEMA AB 1, motor-circuit protector with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes.

D. Overload Relay: NEMA ICS 2, Class 10 tripping characteristics. Ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect, and with appropriate adjustment for duty cycle.

2.4 ENCLOSURES

A. Description: Flush or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 1 unless otherwise indicated on Plans.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.5 ACCESSORIES

A. Devices are factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type, push to test LED type pilot lights. Red running and green stopped pilot lights. Hand-Off-Auto selector switch unless otherwise indicated.

C. Stop and Lockout Push-Button Station: Momentary-break push-button station with a factory-applied hasp arranged so a padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Auxiliary Contacts: Not less than 2 N.O. and 2 N.C. contacts.

F. Elapsed Time Meters: Heavy duty with digital readout in hours.

G. Legend Plates: Provide for push buttons, pilot lights and selector switches.

H. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide transfer device with an off position. Meters indicate the following:

1. Ammeter: To indicate output current, with current sensors rated to suit application.
2. Voltmeter: To indicate output voltage.

I. Meters: Multi-function microprocessor meter.

J. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

K. Current-Sensing, Phase-Failure Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage. Provide adjustable response delay.

L. Surge Protective Devices: IEEE C62.41, selected to meet requirements for a medium-exposure category.

M. Impulse sparkover voltage coordinated with system circuit voltage.

N. Factory mounted with Nationally Recognized Testing Laboratory listed and labeled mounting device.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

D. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

3.2 INSTALLATION

A. Install independently mounted motor-control devices according to manufacturer's written instructions.

B. Location: Locate controllers within sight of motors controlled, unless otherwise indicated. Mount with operating mechanism 5'-0" above floor or as indicated on drawings.

C. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Division 26.

D. Install freestanding equipment on concrete housekeeping bases conforming to Division 3 Section "Cast-in-Place Concrete."

E. Motor-Controller Fuses: Install indicated fuses in each fusible switch.

3.3 IDENTIFICATION

A. Identify motor-control components and control wiring according to Division 26, Section 26 0553, Identification for Electrical Systems.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 26, Section 26 0519, Low Voltage Electrical Power Conductors and Cables.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic control devices where available.

1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.

3.5 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

A. Testing: After installing motor controllers and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
2. Remove and replace malfunctioning units with new units, and retest.

3.7 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

3.8 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to demonstrate solid-state and variable-speed controllers and train Owner's maintenance personnel.

1. Conduct a minimum of four (4) hours of training in operation and maintenance as specified in Division 1 Section Contract Closeout. Include training relating to equipment operation and maintenance procedures.
2. Schedule training with at least seven (7) days' advance notice.

END OF SECTION 262913

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Type 1 surge protective devices.
2. Type 2 surge protective devices.
3. Enclosures.
4. Conductors and cables.

B. Related Requirements:

1. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
2. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
3. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. NRTL: Nationally recognized testing laboratory.

F. OCPD: Overcurrent protective device.

G. SCCR: Short-circuit current rating.

H. SPD: Surge protective device.

I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

K. Type 3 SPDs: Point of utilization SPDs.

L. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include electrical characteristics, specialties, and accessories for SPDs.
2. NRTL certification of compliance with UL 1449.

a. Tested values for VPRs.
b. Inominal ratings.
c. MCOV, type designations.
d. OCPD requirements.
e. Manufacturer's model number.
f. System voltage.
g. Modes of protection.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

A. Source Limitations: Obtain devices from single source from single manufacturer.

B. Standards:

1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.

C. Product Options:

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V ac for remote monitoring of protection status.
6. Include surge counter.

D. Performance Criteria:

1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 160 kA for Panelboards and 320 kA for Switchboards. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    b. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.

4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Line: 1200 V.

5. SCCR: Not less than 200 kA.
6. Inominal Rating: 20 kA.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Source Limitations: Obtain devices from single source from single manufacturer.

B. Standards:

1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.
2. Comply with UL 1283.

C. Product Options:

1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at 2A and 24V ac for remote monitoring of protection status.
4. Include surge counter.

D. Performance Criteria:

1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA for panelboards and 150 kA for Switchboards kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    b. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    c. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    d. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.

4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Ground: 700 V.
    c. Neutral to Ground: 700 V.
    d. Line to Line: 1200 V.

5. SCCR: Equal or exceed 100 kA.
6. Inominal Rating: 10 kA.

2.3 TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDs)

A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's written instructions.

C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's written instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. SPDs that do not pass tests and inspections will be considered defective.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265618 - INTERIOR LED LUMINAIRES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79, IES LM-80 and IESNA TM-21-11.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

7. Include lighting calculations for each space using standard reflectances and working plane height of 30” AFF for comparison to Basis of Design.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of luminaire.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty for all luminaire types: Manufacturer and Installer agree to repair or replace any and all components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship for Five years from date of Substantial Completion.
2. The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents
3. Failures include, but are not limited to, the following:

    a. Structural failures, including luminaire support components.
    b. Faulty operation of luminaires and accessories.
    c. Deterioration of metals, metal finishes, and other materials beyond normal weathering. Warranty against perforation or erosion of finish due to weathering.
    d. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.

e. Installation defects that may create faulty issues

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and LEDs shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. CRI of minimum 80. CCT of 3500K.

F. Rated lamp life of 50,000 hours.

G. LEDs dimmable from 100 percent to 0 percent of maximum light output.

2.3 INTERNAL LINEAR DRIVER

A. Physical Characteristics

A. Driver shall be available in an all metal-can construction for optimal thermal performance.

B. Driver shall have a slim profile with height ≤ 1 in and width ≤ 1.2 in.

C. Driver shall be provided with integral color-coded connectors.

B. Performance Requirements

A. Driver shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage) with no damage to the Driver.

B. Driver output shall be regulated to +/- 5% across published load range.

C. Driver shall have an easy way to lower the output current, without using the dimming leads.

D. Driver shall have a Power Factor greater than 0.90 for primary application to 50% of full load rating.

E. Driver input current shall have Total Harmonic Distortion (THD) of less than 20% to 50% of full load rating.

F. Driver shall have a Class A sound rating.

G. Driver shall have a minimum operating temperature of -20C (-4F).

H. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.

I. Driver output ripple current shall be less than 15% measured peak-to-average, with ripple frequency >100Hz.

J. Driver performance requirements shall be met when operated to 50% of full load rating.

K. Driver shall be rated for UL Damp and Dry locations.

L. Driver shall have integral common mode and differential mode surge protection of 2.5kV(100kHz 30ohm ring wave).

M. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.

N. Driver shall comply with NEMA 410 for in-rush current limits.

O. Driver shall incorporate an integral means of limiting surges to the LEDs.

C. Regulatory

A. Driver shall not contain any Polychlorinated Biphenyl (PCB).

B. Driver shall be Underwriters Laboratories (UL) recognized Class 2 per UL1310 or Canadian Standards Association (CSA) recognized Class 2 per CSA-C22.2.

C. Driver shall comply with applicable requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, for Non-Consumer equipment.

D. Driver shall be RoHS compliant.

D. Other

A. Driver shall be manufactured in a factory certified to ISO 9001 Quality System Standards.

B. Driver shall carry a five-year limited warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 75C

C. Dimmable drivers shall be controlled by a Class 2 low voltage 0-10VDC controller with dimming range controlled between 1 and 8VDC with source current 150µA.

D. Manufacturer shall have a 10-year history of producing electronic drivers for the North American market.

E. Nominal Operating Voltage: Multi tap drivers will provide 120Vac and/or 277Vac.

2.4 INTERNAL DOWNLIGHT DRIVER

A. Physical Characteristics

A. Driver shall be available in an all metal-can construction for optimal thermal performance.

B. Driver shall be in a compact enclosure with integrated studs so that it can be mounted on the outside or a junction box, without the need of an additional enclosure.

C. Driver shall be provided with integral color-coded connectors.

B. Performance Requirements

A. Driver shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage) with no damage to the Driver.

B. Driver output shall be regulated to +/- 5% across published load range.

C. Driver shall have an easy way to lower the output current, without using the dimming leads.

D. Driver shall have a Power Factor greater than 0.90 for primary application to 50% of full load rating.

E. Driver input current shall have Total Harmonic Distortion (THD) of less than 20% to 50% of full load rating.

F. Driver shall have a Class A sound rating.

G. Driver shall have a minimum operating temperature of -20C (-4F).

H. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.

I. Driver output ripple current shall be less than 15% measured peak-to-average, with ripple frequency >100Hz.

J. Driver performance requirements shall be met when operated to 50% of full load rating.

K. Driver shall be rated for UL Damp and Dry locations.

L. Driver shall have integral common mode and differential mode surge protection of 2.5kV(100kHz 30ohm ring wave).

M. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.

N. Driver shall comply with NEMA 410 for in-rush current limits.

O. Driver shall incorporate an integral means of limiting surges to the LEDs.

C. Regulatory

A. Driver shall not contain any Polychlorinated Biphenyl (PCB).

B. Driver shall be Underwriters Laboratories (UL) recognized Class 2 per UL1310 or Canadian Standards Association (CSA) recognized Class 2 per CSA-C22.2.

C. Driver shall comply with applicable requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, for Non-Consumer equipment.

D. Driver shall be RoHS compliant.

D. Other

A. Driver shall be manufactured in a factory certified to ISO 9001 Quality System Standards.

B. Driver shall carry a five-year limited warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 75C.

C. Dimmable drivers shall be controlled by a Class 2 low voltage 0-10VDC controller with dimming range controlled between 1 and 8VDC with source current 150µA.

D. Manufacturer shall have a 10-year history of producing electronic drivers for the North American market.

E. Nominal Operating Voltage: Multi tap drivers will provide 120Vac and/or 277Vac

2.5 DOWNLIGHT

A. **Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project.**

B. Minimum **1,000** lumens. Minimum allowable efficacy of **80** lumens per watt. Unless noted otherwise on luminaires schedule.

C. Universal mounting bracket.

D. Integral junction box with conduit fittings.

2.6 STRIP LIGHT

A. <u>Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project.</u>

B. Minimum **750** lumens. Minimum allowable efficacy of **80** lumens per watt.

C. Integral junction box with conduit fittings.

2.7 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.

3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit new LEDs without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during replacement and when secured in operating position.

C. Housings:

1. Will be as called for in the Luminaire Schedule for this project. This will include housing and heat sink.
2. Powder-coat and painted finish. Unless otherwise noted in the luminaire schedule for this project.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.8 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.9 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and replacement of LEDs.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached using through bolts and backing plates on either side of wall as means of attachment.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Recessed-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. ADJUSTING

E. Occupancy Adjustments: When requested within **12** months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to **two** visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace drivers or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265618

SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Division 26, Section 26 5618, LED Interior Lighting, for interior Luminaires, and accessories.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Luminaire: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including LEDs, Drivers, Reflector, and Housing.

1.4 ACTION SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections

B. Product Data: For each type of luminaire.

1. Arrange in order of luminaire schedule designation.
2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaire.
4. LEDs, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for LEDs and accessories identical to those indicated for the luminaire as applied in this Project; IES LM-79 and IES LM-80

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring. Wiring diagrams for control system showing both factory-installed and field-installed wiring for specific system of this Project, and differentiating between factory-installed and field-installed wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
9. Luminaire, LEDs, Drivers, Poles, and accessories. Include data on features, Poles, accessories, finishes, and the following:

    a. Outline drawings indicating dimensions and principal features of Luminaire and Poles.
    b. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for Luminaires and LEDs.

10. Wind Resistance Calculations: Certified by a registered professional engineer
11. Anchor-Bolt Templates: Keyed to specific **poles** and certified by manufacturer.
12. Field test reports indicating and interpreting test results specified in Part 3 of this section.
13. Maintenance data for products to include in the operation and maintenance manual specified in Division 1.
14. Product certificates signed by manufacturers of lighting units certifying that their products comply with specified requirements.

C. Include lighting calculations for each space using the following reflectance's, 75,45,20, and working plane height of 30" AFF for comparison to Basis of Design

D. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

E. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

F. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Structural members to which luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Sample warranty.

1.6 PRIOR APPROVAL

A. General: Luminaire schedule list several manufacturers that are approved for use in bidding this project.

B. Prior Approval Request: A Request for prior approval will require the following.

1. Submit each item in this article according to the conditions per prior approval outlined in Division 26, Section 26 0500, Common Work Results for Electrical.
2. Provide a sample of the actual Luminaire proposed for approval.

3. Provide point-by-point calculations for areas served by proposed Luminaire. Provide lighting calculations for each space using the following reflectance's, 75,45,20, and working plane height of 30" AFF for comparison to Basis of Design.
4. Information must be received by Engineer three (3) weeks prior to bid date.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all LED types used on Project. Use ANSI and manufacturers' codes.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. LEDs: One for every 50 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 50 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 50 of each type and rating installed. Furnish at least one of each type.

1.9 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

B. Listing and Labeling: Provide Luminaires and accessories specified in this Section that are listed and labeled for their indicated use and installation conditions on Project.

1. Special Listing and Labeling: Provide Luminaires for use underwater that are specifically listed and labeled for such use. Provide Luminaires for use in hazardous (classified) locations that are listed and labeled for the specific hazard.
2. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
3. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

F. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. General: Store poles on decay-resistant treated skids at least 12 inches above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation

B. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

C. Metal Poles: Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps

1.11 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.12 WARRANTY

A. Warranty for all luminaire types: Manufacturer and Installer agree to repair or replace any and all components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship for Five years from date of Substantial Completion.
2. The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in

addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents

3. Failures include, but are not limited to, the following:

    a. Structural failures, including luminaire support components.
    b. Faulty operation of luminaires and accessories.
    c. Deterioration of metals, metal finishes, and other materials beyond normal weathering. Warranty against perforation or erosion of finish due to weathering.
    d. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.
    e. Installation defects that may create faulty issues.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to SCE/SEI 7.

B. Seismic Performance: Luminaires and LEDs shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.3 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location where indicated in Luminaire schedule.

E. Bulb shape complying with ANSI C79.1.

F. CRI of minimum 80.

G. CCT of 4100 K or as indicated in the luminaire schedule.

H. L70 LED life of 50,000 minimum hours.

I. Internal driver.

J. Nominal Operating Voltage: Multi-Tap Drivers - 120 V or 277 V.

K. In-line Fusing: Separate in-line fuse for each luminaire.

L. LED Rating: LED marked for outdoor use.

M. Source Limitations: Obtain luminaires from single source from a single manufacturer.

N. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

O. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed Luminaires.

P. Exposed Hardware Material: Stainless steel.

Q. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

R. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in Luminaire doors.

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are not acceptable. Arm, Bracket, and Tenon Mount will match poles' finish.

B. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected by Architect from manufacturer's full range.

C. Mountings, Fastenings, and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Pole-Mounted Luminaires: Conform to AASHTO LTS-3.

C. Wind-load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, is adequate to carry itself plus Luminaires indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 Mi./Hr. with a gust factor of 1.3.

D. Poles: Provide factory installed vibration dampers.

E. Pole Shafts: Round, straight.

F. Pole Bases: Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts, and bolt covers.

G. Poles: Steel tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psi. Poles are 1-piece construction up to 40 feet in length and have access handhole in wall.

H. Metal Pole Grounding Provisions: Welded 1/2-inch threaded lug, accessible through handhole.

I. Steel Mast Arms: Fabricated from 2-inch NPS (DN50) black steel pipe, continuously welded to pole attachment plate with span and rise as indicated.

J. Metal Pole Brackets: Designed to match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate Luminaire.

K. Pole-Top Tenons: Fabricated to support Luminaire or Luminaires and brackets indicated and securely fastened to pole top.

L. Concrete for Pole Foundations: Comply with structural details for the base required for Poles on this project. Details in this division drawings indicate electrical information and do not call out any structural information.

1. Construct according to Division 3, Section03 3000, Cast-in-Place Concrete.
2. Comply with details and manufacturer's recommendations for reinforcing, anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.
3. Finish: Trowel and rub smooth parts exposed to view

M. Embedded Poles: Set poles to indicated depth, but not less than 1/6 of pole length below finish grade. Dig holes large enough to permit use of tampers the full depth of hole. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

N. Pole Installation: Use web fabric slings (not chain or cable) to raise and set poles.

O. Luminaire Attachment: Fasten to indicated structural supports.

P. Luminaire Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution.

Q. Provide LED Luminaires with indicated LEDs according to manufacturer's written instructions. Replace malfunctioning LEDs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached using through bolts and backing plates on either side of wall.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Set Luminaires securely according to manufacturer's written instructions and approved Shop Drawings. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

H. Coordinate layout and installation of luminaires with other construction.

I. Luminaire Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution. Adjust luminaires that require field adjustment or aiming once luminaire is in place .

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

K. Provide LED Luminaires with indicated LEDs according to manufacturer's written instructions. Replace malfunctioning LEDs

3.4 GROUNDING

A. Ground fixtures and metal poles according to Division 26, Section 26 0526, Grounding and Bonding for Electrical Systems.

1. Poles: Install 10-foot driven ground rod at each pole.
2. Nonmetallic Poles: Ground metallic components of lighting unit and foundations. Connect fixtures to grounding system with No. 6 AWG conductor, minimum

3.5 CORROSION PREVENTION

A. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Give advance notice of dates and times for field tests.

C. Provide instruments to make and record test results. Use photometers with calibration referenced to National Institute of Standards and Technology (NIST) standards.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, control system, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.
3. Check for intensity of illumination.
4. Check for uniformity of illumination.
5. Check for excessively noisy Driver.

E. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

   a. IES LM-5.
   b. IES LM-50.
   c. IES LM-52.
   d. IES LM-64.
   e. IES LM-72.

F. Luminaire will be considered defective if it does not pass tests and inspections. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until all units operate properly

G. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.9 ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer. Adjust aimable fixtures to provide required light intensities.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace LEDs or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

3.10 EXTERIOR LIGHTING FIXTURE SCHEDULE

A. The luminaire schedule located in the construction drawings describes each type of luminaire for the project. Manufacturer's catalog numbers are given for convenience. Where discrepancies occur between catalog numbers and the descriptive information, the descriptive information shall take precedence. Some required features, options, accessory equipment or special order requirements may not be included in the catalog number.

END OF SECTION 265619

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 1 Specification Sections apply to all Sections of Division 27.

B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 27 and form a part of the contract.

C. See Division 2, Site Work for Trenching, Backfilling and Compaction requirements.

D. See Division 1, Coordination for additional requirements.

E. See Division 1, Cutting and Patching for additional requirements.

F. See Division 1, Submittals for additional requirements.

G. See Division 5, Metal Fabrication for additional requirements.

H. See Division 7, Firestopping for additional requirements.

I. See Division 7, Joint Sealants for additional requirements.

J. See Division 9, Painting for additional requirements.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals
2. Coordination Drawings
3. Record Documents
4. Maintenance Manuals
5. Rough-Ins
6. Electrical Installations
7. Cutting and Patching

1.3 ELECTRICAL DIVISION INDEX

Section 27 0500, Common Work Results for Communications

Section 27 0502, Demolition for Communications Systems
Section 27 0526, Grounding and Bonding for Communications Systems
Section 27 0528, Pathways for Communications Systems
Section 27 0536, Cable Trays for Communications Systems
Section 27 0544, Sleeves and Sleeve Seals for Communications Pathways and Cabling
Section 27 1500, Communications Horizontal Cabling
Section 27 5123, Intercommunications and Program Systems

1.4 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. BCT: Bonding conductor for telecommunications.

C. BICSI: Building Industry Consulting Service International.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. EMT: Electrical metallic tubing.

H. GRC: Galvanized rigid steel conduit.

I. IDC: Insulation displacement connector.

J. IMC: Intermediate metal conduit.

K. Inter-building Backbone cable: UTP, optical fiber, and coaxial cable that connects telecommunications rooms that are in separate buildings.

L. Intra-building Backbone cable: UTP, optical fiber, and coaxial cable that connects telecommunications rooms that are within the same buildings.

M. LAN: Local area network.

N. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

O. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

P. TBB: Telecommunications Bonding Backbone.

Q. TGB: Telecommunications grounding busbar. Term used synonymously with BCT.

R. TMGB: Telecommunications main grounding busbar.

S. TR: Telecommunications Room.

T. RCDD: Registered Communications Distribution Designer.

U. UTP: Unshielded twisted pair.

1.5 STANDARDS AND CODES

A. Telecommunications design and installations shall adhere with industry standards, including but not limited to:

1. NFPA-70, National Electrical Code
2. NFPA-72, National Fire Alarm and Signaling Code
3. BICSI Telecommunications Distribution Methods Manual (TDMM), 13th Edition
4. ANSI/TIA/EIA-568-C: Generic Telecommunications Cabling for Customer Premises
5. ANSI/TIA/EIA-568-C: Commercial Building Telecommunications Cabling Standard
6. ANSI/TIA/EIA-568-C: Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling
7. ANSI/TIA/EIA-568-C: Optical Fiber Cabling Components Standard
8. ANSI/TIA/EIA-TIA-569-D: Commercial Building Standard for Telecommunications Pathways and Spaces
9. ANSI/TIA/EIA-598-D: Color Coding of Fiber Optic Cables
10. ANSI/TIA/EIA-606-B: The Administration Standard for the Telecommunications Infrastructure of Commercial Building
11. ANSI/TIA/EIA-607-B: Commercial Building Grounding and Bonding Requirements for Telecommunications
12. ANSI/TIA/EIA-758-B: Customer Owned Outside Plant Telecommunications Cabling Standard
13. ANSI/TIA/EIA-526-14-C: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.

B. Comply with local AHJ codes and requirements in addition to these listed.

C. Above referenced standards are to be most current version published at the time specifications are issued, including addendums, and technical services bulletins.

1.6 RECORD DRAWINGS

A. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Use red color to indicate additions or corrections to prints, green color to indicate deletions, and yellow color to indicate items were installed as shown. Keep record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect/Engineer during the construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set. Transmit drawings to the Architect/Engineer at the conclusion of the project for delivery to the Owner's Representative.

B. Prepare record documents in accordance with the requirements in Division 1, Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.7 QUALIFICATIONS

A. Refer to Division 27 sections for installation and testing qualifications.

1.8 SUBSTITUTIONS

A. Refer to the requirements for substitutions in Division 01.

B. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls, which shall conform to the manufacturer's recommendations and these specifications. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.

1.9 HAZARDOUS CONDITIONS

A. Refer to Division 01 requirements related to the treatment of parts or items that are potentially hazardous to building occupants, maintenance and operation personnel, or to the public.

1.10 DEFINITIONS

A. Definitions of terms will be found in the National Electrical Code.

B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.

C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.

D. "Provide" means furnish, install, connect and test unless otherwise noted.

1.11 SUBMITTALS

A. See Division 1 for all submission requirements.

1.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1, Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and schedules.

1.13 DRAWINGS AND SPECIFICATIONS

A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.

B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.

C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Architect.

D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.

E. The Architect shall interpret the drawings and the specifications. The Architect's interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.

F. In the case of conflicts not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.

G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.14 SIMILAR MATERIALS

A. All items of a similar type shall be products of the same manufacturer.

B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.

1.15 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.16 GUARANTEE-WARRANTY

A. See Division 1 for warranties for more information.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

> "The Contractor guarantees that this installation is free from ALL defects. He agrees to replace or repair any part of the installation which may fail within a period of one (1) year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date to be determined in writing by means of issuing a 'Certificate of Substantial Completion', AIA Form G704."

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of electrical equipment furnished and installed under Division 27 shall be provided with a full two (1) year parts and labor warranty.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 5,400 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 EQUIPMENT REQUIREMENTS

A. The electrical requirements for equipment specified or indicated on the drawings are based on information available at the time of design. If equipment furnished for installation has electrical requirements other than those indicated on the electrical drawings, make all adjustments to wire and conduit size, controls, over current protection and installation as required to accommodate the equipment supplied. Delineate all adjustments to the drawings reflecting the electrical system in a submittal to the Contract Administrator immediately upon knowledge of the required adjustment.

B. Approved Equipment and Conductors: All electrical equipment and its components and materials shall meet all applicable UL criteria and bear the appropriate label of the UL. Where UL is not applicable or available, equipment shall be listed and labeled by a nationally recognized testing laboratory (NRTL). The NRTL shall be listed by the federal occupational safety and health administration.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The electrical drawings show the general arrangement of all special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefore, shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval. All changes shall be marked on record drawings.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 27 with the associated architectural, structural, and mechanical work than is normally necessary for a more typical facility.

E. The installation of all concealed communication systems shall be carefully arranged to fit within the available space without interference with adjacent structural, mechanical and other electrical systems.

3.3 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of the communication systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical and communication systems, equipment, and materials installation with all other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical and communication systems installation.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
5. Sequence, coordinate, and integrate installations of communication systems materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.
7. Coordinate connection of communication systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
10. Install communication systems equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Install access panel or doors where units are concealed behind finished surfaces.
12. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

3.4 FIELD MEASUREMENTS

A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall report any work which must be

corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.5 EQUIPMENT SUPPORT

A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.6 PAINTING

A. All finish painting of communication systems and equipment will be under "Painting," unless equipment is hereinafter specified to be painted.

B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Architect/Engineer.

3.7 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of communication systems equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Architect/Engineer.

C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect/Engineer prior to such storage.

D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect/Engineer.

3.8 EXCAVATION

A. Provide all excavation, trenching and backfilling required.

B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.11 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer’s printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.12 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.13 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1, Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements

apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
   a. Remove and replace defective Work.
   b. Remove and replace Work not conforming to requirements of the Contract Documents.
   c. Remove samples of installed Work as specified for testing.
   d. Install equipment and materials in existing structures.
   e. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.
2. Cut, remove, and legally dispose of selected communication systems equipment, components, and materials as indicated, including but not limited to removal of items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. During cutting and patching operations, protect adjacent installations.
6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.14 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Architect/Engineer who shall make such compromises as he deems necessary and desirable.

3.15 TESTS

A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect/Engineer one week in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.16 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish the complete operating and maintenance instructions covering all units of electrical equipment herein specified together with parts lists. Furnish four (4) copies of all the literature; each shall be suitably bound in loose leaf book form.

B. Operating and maintenance manuals as required herein shall be submitted for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the communication systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the

subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

D. The Contractor shall video tape the instruction and training sessions using a VHS camcorder, and at the completion and acceptance (by Owner and Architect) of the training sessions, the Contractor shall submit (2) copies of the video tape.

3.17 CERTIFICATIONS

A. Before receiving final payment, certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Architect/Engineer including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.18 INTERRUPTING SERVICES

A. The Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing building electrical telephone, fire alarm, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written review of the request.

3.19 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

3.20 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Architect/Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Architect/Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Architect/Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 270500

DIVISION 27 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? ☐ YES ☐ NO
   If YES, explain: _____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
9. Is substitution identical in appearance and function to specialized product? YES ☐ NO ☐

SECTION 270502 - DEMOLITION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 1 Specification Sections apply to this Section.

B. See Section 27 0500 for Common Work Results for Communications.

1.2 SCOPE OF WORK

A. Provide all material, equipment and labor as required to remove, relocate and/or reconnect all electrical work identified in these specifications and indicated on the drawings.

1.3 SUMMARY

A. This Section includes limited scope, general construction materials and methods for application with electrical installations as follows:

1. Selective demolition including:

    a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
    b. Dismantling electrical materials and equipment made obsolete by these installations.

2. Excavation for underground utilities and services, including underground raceways.
3. Miscellaneous metals for support of electrical materials and equipment.
4. Nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
5. Joint sealers for sealing around communication systems materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
6. Access panels and doors in walls, ceilings, and floors for access to communication systems materials and equipment.

1.4 PROJECT CONDITIONS

A. Conditions affecting selective demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify, and protect communication systems services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected

areas.

B. Conditions affecting excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
3. Existing utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
4. Remove existing underground utilities indicated to be removed.

    a. Uncharted or incorrectly charted utilities: Contact utility owner immediately for instructions.
    b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Owner's Representative prior to utility interruption.

5. Use of explosives is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Verify field measurements and circuiting arrangements as shown on drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect/Engineer before disturbing existing installation.

E. Beginning of demolition means Contractor accepts existing conditions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Disconnect and remove communication systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with Owner a minimum of 72 hours prior to outage.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Telephone system: Maintain existing system in service until new system is complete and ready for

service. Disable system only to make switch overs and connections. Obtain permission from the Owner's Representative at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Paging system: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner's Representative at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.2 DEMOLITION AND EXTENSION OF EXISTING COMMUNICATION SYSTEMS WORK

A. Demolish and extend existing communication systems work under provisions of this section.

B. Remove, relocate and extend existing installations to accommodate new construction. Recircuit and reconnect all electrical lighting, outlets and equipment not scheduled for removal that have become disconnected due to demolition work.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit serving them is removed. Provide blank cover for abandoned outlets which are not removed. Provide blank cover for abandoned outlets which are not removed.

F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

G. Repair adjacent construction and finishes damaged during demolition and extension work. Any damage to building, piping or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.

H. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

I. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

J. Removal and replacement of ceiling tile(s) to perform work operations shall be the responsibility of the Contractor. The Contractor shall be responsible for replacement of any ceiling tiles or framework that may become damaged at no cost to the Owner.

K. Conduit in Concealed Locations: Remove conductors, cap both ends of conduit, and label conduit as "Abandoned" at both ends. Where conduit runs below grade, cap both ends of conduit and abandon in place. Where conduit runs below floor slab, additionally, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match existing.

3.3 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Materials and equipment to be salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

C. Disposal and cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

3.4 INSTALLATION

A. Install relocated materials and equipment under the provisions of this section.

3.5 ITEMS SALVAGED TO OWNER

A. Items salvaged to Owner are as indicated on drawings. Move and store in dry location as directed. Refuse materials and items not salvaged shall be removed from the site and legally disposed of.

END OF SECTION 270502

SECTION 270526 - GROUNDING AND BONDING 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. TGB: Telecommunications grounding busbar.

C. TMGB: Telecommunications main grounding busbar.

D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT,

4. TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For Installer, installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agencies field supervisor.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D.

F. Grounding: Comply with TIA-607-B.

1.8 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm) long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Harger Lightning and Grounding.
2. Tyco Electronics Corp.

B. Ground Rods: Zinc-coated steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

2.6 IDENTIFICATION

A. Comply with requirements for identification products in Section 260553 "Identification for Electrical Systems."

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brother International Corporation.
2. HellermannTyton.
3. Panduit Corp.

C. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

D. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-B.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm).

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.

4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack

grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.

1. Install the conductors in grid pattern on 4-foot (1200-mm) centers, allowing bonding of one pedestal from each access floor tile.
2. Bond the TGB of the equipment room to the reference grid at two or more locations.
3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Hooks.
4. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. EMT: Electrical Metallic Tubing

C. FMC: Flexible Metal Conduit (Shall not be used for Communication pathways

D. GRC: Galvanized rigid steel conduit.

E. IMC: Intermediate metal conduit.

F. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.

3. Boxes, enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D.

F. Grounding: Comply with TIA-607-B.

1.6 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Alpha Wire Company.
4. Anamet Electrical, Inc.
5. Electri-Flex Company.
6. O-Z/Gedney.
7. Picoma Industries.
8. Republic Conduit.
9. Robroy Industries.

10. Southwire Company.
11. Thomas & Betts Corporation.
12. Western Tube and Conduit Corporation.
13. Wheatland Tube Company.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: Set screw.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.

3. Anamet Electrical, Inc.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corporation.
7. Condux International, Inc.
8. Electri-Flex Company.
9. Kraloy.
10. Lamson & Sessions; Carlon Electrical Products.
11. Niedax-Kleinhuis USA, Inc.
12. RACO; Hubbell.
13. Thomas & Betts Corporation.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651A.

F. RTRC: Comply with UL 2515A and NEMA TC 14.

G. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

A. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B- Line System #781011 04762
   #781011 04874
   #781011 04770
   #781011 04875
2. Erico Caddy Cat HP System
3. Erico Caddy Cat CM System

E. Galvanized steel.

F. J or U shape.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. Hoffman.
6. Lamson & Sessions; Carlon Electrical Products.
7. Milbank Manufacturing Co.
8. Molex; Woodhead Brand.
9. Mono-Systems, Inc.
10. O-Z/Gedney.
11. Quazite:Hubbell Power Systems, Inc.
12. RACO; Hubbell.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

    a. Material: Plastic.
    b. Finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: IMC.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: IMC. Pathway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: IMC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, communications-cable pathway.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.

9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper and aluminum cables, and 1 inch (25 mm) for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use set-screw, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm) of enclosures to which attached.

L. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from nonmetallic conduit and fittings to IMC and fittings before rising above floor.

M. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

U. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
2. 1-Inch (25-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

V. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

W. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

X. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Y. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet (1.5 m) o.c.
5. Provide a hook at each change in direction.

AA. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

CC. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set metal floor boxes level and flush with finished floor surface.

GG. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete around conduit for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

3.4 SLEEVE & SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270536 - CABLE TRAYS 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Cable tray accessories.
4. Warning signs.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D.

F. Grounding: Comply with TIA-607-B.

1.5 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CPI Chatsworth.
2. Cablofil/Legrand
3. Redi-Rail runway/Cooper B-Line, Inc.
4. Mono-Rack/Mono-Systems, Inc.

5. RXL Runway Xpress, Inc.
6. Pentair Hoffman
7. NextFrame/Hubbell.
8. Owner or Consultant approved equal.

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 18 inches (450 mm) unless otherwise indicated on Drawings.
3. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
4. No portion of the rungs shall protrude below the bottom plane of side rails.
5. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 5A.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
4) Hardware: Chromium-zinc plated, ASTM F 1136.

2.4 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. RejiBand/CPI Chatsworth.
2. Cablofil/Legrand.
3. Flextray/Cooper B-Line, Inc.
4. Mono-Mesh/Mono-Systems, Inc.
5. Quick Tray/Pentair Hoffman
6. Hubbell
7. MP Husky

8. WBT Tray
9. Owner or Consultant approved equal.

B. Description:

1. Configuration: Galvanized-steel wire mesh, complying with NEMA VE 1.
2. Width: 12 inches (300 mm), 18 inches (450 mm), unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 2 inches (50 mm).
4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
5. Class Designation: Comply with NEMA VE 1, Class 5A.
6. Splicing Assemblies: Bolted type using serrated flange locknuts.
7. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.

1) Hardware: Galvanized, ASTM B 633.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."

B. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems."

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with trapeze hangers.

N. Support trapeze hangers for wire-basket trays with 1/4-inch (6-mm) diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties Velcro with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D.

F. Grounding: Comply with TIA-607-B.

1.4 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Presealed Systems.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Cable connecting hardware, patch panels, and cross-connects.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.
5. Warranty

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: One of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

F. Grounding: Comply with TIA-607-B.

1.10 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall

have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA-568-C.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Panduit.
2. General Cable
3. Hubbell Premise Wiring.
4. Superior Essex Inc.
5. SignaMax.
6. Commscope Inc. (NETCONNECT)
7. Commscope Inc. (SYSTIMAX)
8. Commscope Inc. (Uniprise)
9. Berk-Tek; Leviton / (Nexans)
10. Superior Essex; Legrand / (nCompass)
11. Corning (LANscape)
12. Belden Inc.
13. Owner or consultant approved equal.

B. Description: 100-ohm, four-pair UTP, formed into 4-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.1 for performance specifications.
3. Comply with TIA-568-C.2, Category 6, and Category 6a.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Panduit.
2. General Cable
3. Hubbell Premise Wiring.
4. Superior Essex Inc.

5. SignaMax.
6. Commscope Inc. (NETCONNECT)
7. Commscope Inc. (SYSTIMAX)
8. Commscope Inc. (Uniprise)
9. Berk-Tek; Leviton / (Nexans)
10. Superior Essex; Legrand / (nCompass)
11. Corning (LANscape)
12. Belden Inc.
13. Owner or consultant approved equal.

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6 and Category 6a. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Angled modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in 48-inch (1200-mm) lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. 26AWG patch cords minimum for category 6 cabling only.
3. 24AWG patch cords minimum for category 6a cabling only.
4. Patch cords shall have color-coded boots for circuit identification.
5. Patch Cords shall be from the same manufacturer as the cabling solution.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA-568-C.1.

B. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

2. Metal Faceplate: Steel, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle, only for projector location.

4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to TIA-568-C.1.

C. Factory test UTP cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. **Install "wet" rated cable when the voice and data cabling conduit pathway is in the slab or underground. Transition "wet" rated cable to plenum if pathway extends into a plenum space without conduit. Wet rated cable shall not be installed in the open plenum ceiling space.**
3. Comply with requirements in Section 270528 "Pathways for Communications Systems."
4. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1220 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

H. Protect cabling during installation:

1. Protect voice and data cabling cables from any liquid, paints, solvents, debris, or other contaminates, per the manufacturers installation guidelines. Cables shall be replaced if damaged.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding

bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: 2.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA-606-B. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA-606-B.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually confirm Category 6, Category 6a, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

a. Test for each outlet. Perform the following tests according to TIA-568-C.1 and TIA-568-C.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

   a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
   b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer’s warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all

warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

END OF SECTION 271500

SECTION 275123 - INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Microprocessor-switched intercommunications and program systems with the following components:

1. Master stations.
2. Call-switch unit.
3. Loudspeakers/speaker microphones.
4. Conductors and cables.
5. Raceways.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For intercommunications and program systems. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include scaled drawings for master station that detail built-in equipment.
3. Wiring Diagrams: For power, signal, and control wiring.

    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from Installers of the items involved.

B. Qualification Data: For qualified Installer and testing agency.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intercommunications and program systems to include in operation and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. A record of Owner's equipment-programming option decisions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

F. Grounding: Comply with TIA-607-B.

1.7 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall

have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.8 COORDINATION

A. Coordinate layout and installation of ceiling-mounted speaker microphones with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Valcom – Class Connection™ ES IP

B. The Contractor shall furnish and install all equipment including, but not limited to, outlet boxes, wiring, speakers, and all other necessary equipment to provide a complete operating system as indicated with the contract documents. Provide all necessary wall plates, specialty boxes, etc., not provided by others.

C. Class Connection™ ES IP shall be considered as meeting all specifications and as the base bid. No alternate systems will be approved.

D. The intent of this specification is to maximize communications between the classroom and administrative areas utilizing VoIP Technology while enhancing school safety and reducing maintenance, operational, and installation cost.

E. Under this specification, the system shall provide a complete VoIP Communication System for the Administrative, Classroom, Cafeteria, Library, Common, and Recreational areas.

F. Adjacent school building on campus, contractor shall provide provisions to complete existing Class Connection™ ES IP equipment for integration, to communicate between buildings. Campus shall function an all-call for both buildings and independently. Zoning shall be by the school districts discretion.

G. The Communication System shall provide Voice Over IP distribution of intercom, overhead paging, emergency paging, class change time tones, emergency tones and program material.

2.2 COMMUNICATION SYSTEM

The Communication System shall provide at least the following functions and features:

A. The ability to be distributed via a fiber 10/100 switched, VLAN enabled network or 10/100 Switched standalone intercom network. It shall be possible to eliminate the need for copper feeder cables between the Main and Intermediate distribution frames through the use of fiber optics. Fiber optic connected IDFs shall be capable of serving up to 360 zones of intercom/paging and shall feature the ability to support clock correction and/or door relay control signals from any other fiber optic connected IDF in the system.

B. Shall have H.323 and/or SIP, or FXO Port Integration to connect all talk paths to the VoIP phone system of choice. This integration shall give the phone system vendor the option of utilizing the Call Manager Resource Tool to manage all ports connected to and from their system.

C. Direct dialed, hands-free, two-way communication from all administrative telephones to any location equipped with a talkback speaker.

D. Automatic gain control on intercom speech to assure constant talkback speech level.

E. Voice Over IP Integration and distribution microprocessor based system capable of handling up to 720 points (seven hundred twenty). A point is defined as a call-in switch or a speaker output.

F. System shall be modular in design and capable of expanding in increments of 48 points allowing for budget flexibility and expandability.

G. System shall interface with any VoIP telephone system, utilizing H.323, SIP, or FXO Port type integration thus allowing the school(s) to upgrade or replace their telephone system without suffering a requirement to replace, or lose any feature of, their internal communications (intercom) system. Any system that limits system features based upon any selected telephone system, and is not H.323 or SIP or FXO Port interfaced shall not be acceptable.

H. Automatically sound a tone or play a pre-page WAV file over any loudspeaker connected for two-way communication to alert the classroom teacher that this two-way call has been established. This is intended to prevent unauthorized monitoring. The privacy tone must repeat every 15 (fifteen) seconds.

I. Distribution of emergency announcement(s) from any authorized telephone to all areas furnished with a loudspeaker. Emergency announcements shall have the highest system priority.

J. Distribution of general announcements from any administrative telephone, staff telephone, or classroom telephone. The system shall be capable of providing all-call, group call, multiple group call, or dial-on-the-fly page groups.

K. Classroom speakers shall be software assignable to any or all of 72 (seventy-two) paging groups.

L. Provide the ability to define and archive unlimited time tone schedules with up to 255 events per schedule. Each scheduled event shall be capable of controlling any one of 6 (six) internal tones; user selected custom audio/voice phrases, audio from any of 3 auxiliary sources or up to 40 relays for building control. Each scheduled audio event shall be distributable to up to 72 audio groups. The system shall feature the ability to automatically initiate up to 8 schedules per day, based upon the day of the week or calendar dates up to one year in advance. Up to 8 daily schedules shall operate simultaneously. Schedule administration, modification and creation functions must be available through administration PC software. Systems that do not allow the school to manage their own schedules with PC software do not offer calendar based scheduling up to one year in advance or require separate page and time groups shall not be acceptable.

M. Provide 1, 2, 3 or 4 digits numbering plan, thus allowing the classroom speaker and the classroom telephone to be the same architectural number.

N. Provide facilities for up to 7 (seven) call-in priority levels. Each classroom call button shall be assignable to any one or two of these priority levels. The call button priority levels shall have the capacity to change state on a time of day basis. The priority levels shall be as follows:

1. Normal
2. Security
3. Normal/Emergency
4. Urgent/Emergency
5. Overhead Ring
6. Emergency Only
7. Ignore

O. Call button priority levels shall determine call queue placement. Emergency calls will be answered first; urgent calls second and normal calls last.

P. System shall be capable of placing intercoms call on hold in order to perform other administrative functions.

Q. Any classroom/area loudspeaker must have the flexibility to be programmed as a testing room. A testing room shall be excluded from receiving general announcements, class change tones, group announcements and program material. The testing room must receive emergency tones and announcements. A dial code must be provided that will access these testing rooms at the same time, allowing for an announcement to the testing rooms for applications such as standardized testing. The testing rooms may be reactivated to normal operation at any time by the administration staff as needed. Testing rooms shall automatically be reset to normal operation before start of class the next day.

R. Programmable features shall be stored in non-volatile memory and shall not be lost due to power failures.

S. Classroom initiated intercom calls must be able to be assigned to ring at specific administrative ports. These administrative ports shall have the flexibility to be forwarded to other administrative ports should a call go unanswered or should the assigned administrative port be busy.

T. Facilities to annunciate incoming intercom calls at multiple administrative phones simultaneously. Calls may be answered from any of the administrative telephones by simply lifting handset, dialing the room number or pressing a button on telephone. Once answered, the call will automatically be cancelled for other administrative phones.

U. System functionality must include the capability to manually distribute up to 5 (five) alert emergency tones via pushbuttons, contact closure, or dial up tones from any administrative telephone. These tones shall be customizable with respect to cadence, type and duration. Dial up tones must only be accessible by authorized users.

V. The system must provide a minimum of 4 (four) ports to be connected to the telephone system via H.323, SIP, or FXO Port integration from the intercom system. These 4 (four) intercom lines shall provide built-in Enhanced Caller Line Identification which will visually announce the name of the teacher or location, the architectural classroom number, and the status of the call-in level; thus allowing interfacing to any Voice over IP telephone system. Intercom systems that require connection via trunk loop start ports to a VoIP telephone shall not be acceptable.

W. The system shall have the ability to control all system relays. Relays shall be controlled through the administrative software, DTMF controlled, automatically cycle at a programmed time of day, follow time schedule events, follow audio group events, follow security calls, and follow emergency and ADA calls. All relays must be software programmable with the flexibility to change as required.

X. The system shall provide at least three simultaneously operating, non-restrictive program distribution channels. The audio program material shall be controlled and distributed with administration PC software allowing simple and easy changes. Systems that require manual operated switch-banks or cumbersome DTMF telephone codes for distribution shall not be acceptable.

Y. The Communication System shall feature the capability to operate a system of cameras such that visual and audible communication may be seamlessly synchronized. The resulting system of cameras and intercom (visual intercom) shall feature a capacity of at least 192 camera locations and 4 administrative monitors. The system shall provide functionality such that each monitor can display a full motion visual broadcast of the area corresponding to any active intercom path. The camera system shall feature a PC based setup utility and shall use standard UTP infrastructure. Systems that do not offer the capability to seamlessly integrate with a camera system as described above shall not be acceptable.

Z. The Communication System shall feature voice call progress. When 2 or more system users attempt to announce into the same area, the unsuccessful user shall be notified via a voice message. When a user’s announcement attempt is overridden by a higher priority announcement, the overridden user shall be notified via a voice message.

AA. The system shall have the ability to store WAV files directly onto the CPU and shall not be lost due to power outage.

BB. The WAV files shall be activated via the Administration Software, Telephone and/or Telephone system, and/or pushbuttons.

CC. The WAV files shall be programmable as to what level of priority they can be broadcast. They shall be programmable as to override any class change tones, normal all call, music, and intercom in the event of an emergency.

DD. The WAV files shall also have the ability to be broadcast into any one or all of the 72 audio groups as well to any zone within the system.

EE. The WAV files shall be have the ability to be broadcast via a schedule for any day of the week or time of the day. They shall also have the ability to be broadcast for any duration of time and repeat number of plays with the ability to select how long the duration is between each repeated broadcast.

FF. The WAV files shall be able to be broadcast via a pushbutton. When this pushbutton is activated it shall be programmable to select which WAV file is broadcast, the priority level, where it is broadcast, and how many times it shall play.

GG. The WAV files shall also have the ability to be a part of the class change tones within the system. These files shall be able to replace any tone within the class change schedules as to offer the flexibility of customizable tones and or phrases in this class change mode.

HH. The WAV files shall be programmable as to replace the hands-free alert tone, repeated alert tone, or the all call alert tones.

2.3 VOICE OVER IP TELEPHONE INTEGRATION

A. All admin access path ports shall be integrated via H.323, SIP, or FXO Port type protocol. This integration shall be seamless and easy to meet all standards as set forth in H.323, SIP, or FXO Port type interfacing. The VoIP Phone System Call Manager shall be used to manage these ports for control and management thus reducing adds, moves and change cost.

B. It shall be possible without the cost of additional hardware/software to incorporate a WAN/LAN district wide paging system by means of the built in VoIP district Paging Adapter. This adapter shall give the district the ability to page each school independently, as a group of schools, or all schools where a Class Connection IP system is installed.

2.4 DISTRIBUTION

A. For a shared network the requirements shall be a VLAN capable 10/100 Ethernet switched with Gig fiber backbone. The recommended installation shall be to create a port based, fully enabled multicasting, VLAN on the network and install the VCRCA Network Intercom Extender on that VLAN.

B. For a dedicated network the requirements shall be a 10/100 Ethernet switched fiber backbone. The VCRCA Network Intercom Extender shall plug into the Ethernet switch and fiber backbone via plug-in Gig Ethernet interface modules. There shall also be an alternative installation where the VCRCA Network Intercom Extender plugs into the Ethernet switch and a fiber backbone via media converters connected from Ethernet switch ports.

2.5 IDF WIRING

A. All wiring shall be listed for the intended purpose. The cabling shall be Category 6 for all connections from the IDF to the classroom and or zone origination point. All classrooms shall be homerun to each local IDF that serves that area. All interior wiring shall be in accordance with new construction guidelines suggested by the Manufacturer; including the speaker and the call-in switch.

2.6 REMOTE CLASSROOM WIRING

A. The Valcom Remote Intercom Device (RID) shall provide connection for a talkback speaker and call in switch in a remote classroom location. This device shall provide intercom, class change tones, emergency tones, and normal / emergency paging via a wireless or wired network to these remote locations.

2.7 CALL-SWITCH UNIT

A. Enclosure: Single-gang box with stainless-steel faceplate.

B. Call Switch: Momentary contact signals system that a call has been placed.

C. Privacy Switch: Prevents transmission of sound signals from station to system.

D. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.

E. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

2.8 CONE-TYPE LOUDSPEAKERS/SPEAKER MICROPHONES

A. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.

B. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.

C. Minimum Dispersion Angle: 100 degrees.

D. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

E. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and factory primed; complete with

mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.

2.9 HORN-TYPE LOUDSPEAKERS/SPEAKER MICROPHONES

A. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.

B. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.

C. Minimum Power Rating of Driver: 15 W, continuous.

D. Minimum Dispersion Angle: 110 degrees.

E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

2.10 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.

B. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.

C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.

D. Plenum Cable: Listed and labeled for plenum installation.

2.11 RACEWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."

B. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

C. Flexible metal conduit is prohibited.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 48 inches (1220 mm) apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

D. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 SYSTEM PROGRAMMING

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at speakers.
    b. Repeat test for four speaker microphones and for each separately controlled zone of paging loudspeakers.
    c. Minimum acceptable ratio is 35 dB.

6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each paging and all-call amplifier, and a minimum of two selected intercommunication amplifiers. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
8. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Intercommunications and program systems will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Perform startup service and initial system programming.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the intercommunications and program systems.

1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.

3.11 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer’s warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

END OF SECTION 275123

SECTION 28 3100 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances. Voice Evacuation.
6. Device guards.
7. Magnetic door holders.
8. Remote annunciator.
9. Addressable interface device.
10. Digital alarm communicator transmitter.
11. Radio alarm transmitter.
12. Network communications.
13. System printer.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
    d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    e. Locate detectors according to manufacturer's written recommendations.
12. Include **voice/alarm** signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction, State or local fire Marshall, prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified, fire-alarm technician; Level III minimum.
    c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Data: Certificates, for fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 7800 "Closeout Submittals" include the following and deliver copies to authorities having jurisdiction:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Record copy of site-specific software.
g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

h. Manufacturer's required maintenance related to system warranty requirements.
i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no less than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no less than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no less than one unit of each type.
4. Detector Bases: Quantity equal to 10 percent of amount of each type installed, but no less than one unit of each type.
5. Keys and Tools: One extra set for access to locked and/or tamper proofed components.
6. Audible and Visual Notification Appliances: Two of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

D. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

1.9 PROJECT CONDITIONS

A. Perform a full test of the system. Document any equipment or components not functioning as designed.

B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice and or horn]/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.
6. Combustible gas detectors.
7. Automatic sprinkler system water flow.
8. Fire-extinguishing system operation.
9. Fire standpipe system.
10. Dry system pressure flow switch.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances, including voice evacuation notices.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Activate preaction system.
12. Recall elevators to primary or alternate recall floors.
13. Activate elevator power shunt trip.
14. Activate emergency lighting control.
15. Activate emergency shutoffs for gas and fuel supplies.
16. Record events in the system memory.
17. Record events by the system printer.
18. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Alert and Action signals of air-sampling detector system.
4. Elevator shunt-trip supervision.
5. Independent fire-detection and -suppression systems.
6. User disabling of zones or individual devices.
7. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Hose cabinet door open.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.

2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.
6. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Notifier.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
b. Include a real-time clock for time annotation of events on the event recorder and printer.
c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
d. The FACP shall be listed for connection to a central-station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands for control of smoke-detector sensitivity and other parameters.

E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class A.
2. Pathway Survivability: Level 1.
3. Install no more than 100 addressable devices on each signaling-line circuit.
4. Serial Interfaces:
    a. One dedicated RS 485 port for central-station operation using point ID DACT.
    b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
    c. One USB and RS 232 port for PC configuration.
    d. One RS 232 port for voice evacuation interface.

F. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

G. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

J. The kitchen hood fire protection system will be monitored by the FACP.

K. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

L. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

    a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.
    c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

M. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

N. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters, and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

O. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.

P. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Notifier

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, breaking-glass or plastic-rod pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
3. Station Reset: Key- or wrench-operated switch.
4. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.6 SYSTEM SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Notifier.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
    b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
    c. Multiple levels of detection sensitivity for each sensor.
    d. Sensitivity levels based on time of day.
8. Locate detectors at least 5’-0” from supply air grilles.
9. Locate detectors at least 12” from luminaires.
10. Consider stratification effects when selecting detector locations.
11. Heat detectors will be provided for any kitchens, boiler rooms, electrical rooms, kiln rooms, or other locations where dirt or debris are likely to cause false alarms.
12. Heat detectors will be intermediate fixed temperature rated.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

D. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).
3. Provide duct detectors in supply and return ducts for air handling units (AHU's) with air velocity of 2,000 cubic feet per minute or greater.
4. Ensure that duct detectors are located prior to any duct splits, or provide a duct detector on each branch of duct work where required for complete coverage.
5. Remote indicator lights and test switches shall be provided for each duct detector.
    a. Locate the detector in the nearest corridor or other common space, wall mounted at 7'-0" above finished floor. Provide permanent label indicating which duct detector is at that location.
    b. When a duct detector is concealed above a ceiling provide a permanent label on the access door or the ceiling tile used for service access to the duct detector, indicating which duct detector is at that location.
6. Provide duct detector with-in 5'-0" of each fire/smoke damper.
7. Activation of a duct detector will shut down the associated unit.
8. Manual override shall be provided for testing of AHU shutdown upon duct detector activation.
9. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
10. Each sensor shall have multiple levels of detection sensitivity.
11. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
12. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.8 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Notifier.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Notifier.

B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

C. Provide a sufficient number of horns/speakers spaced as required to achieve 15 decibels above ambient sound levels and 4 decibels above the maximum sound level in each space.

D. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
2. Provide horns/speakers as required by code and in each corridor, cafeteria, classroom, vocal room, instrumental room, mechanical room, break room, sound proof room, and sleeping rooms.

3. Provide gymnasiums, and auditoriums with either live or pre-recorded voice announcements or visible devices.
4. Where gymnasiums, auditoriums, cafeterias, and the like have a local sound system, provide the means to disengage the sound system upon activation of the fire alarm system and initiate a pre-recorded voice announcement. Provide a local override to allow for live announcements. The override shall time out and resume the pre-recorded message with-in 10 seconds after the end of the live message.

E. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

F. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

G. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

H. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:
    a. Will vary depending on location and volume of space, any of the following could be used: 15, 30, 75, 110, 177, cd.
    b. 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, white.
7. The candela level provided by the strobes shall be coordinated with the application and location as required to meet code requirements.
8. Provide strobes as required by code and in each corridor, cafeteria, classroom, vocal room, instrumental room, mechanical room, break room, sound proof room, and sleeping rooms

I. Provide separate circuits to the horns and strobes to enable separate horn/speaker silence features.

J. Provide audible/visual notification with-in 15’-0” of all exits.

K. Provide an exterior weatherproof horn/strobe at the fire department Siamese connection or at the point of entry of the fire department where a Siamese connection is not located.

L. Provide two-way communication between areas of refuge and the FACP.

M. Voice/Tone Notification Appliances:

1. Comply with UL 1480.

2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Flush or surface mounted and bidirectional.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

N. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.10 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

C. Configure door hold-opens to close upon any alarm.

D. Coordinate voltage requirements for magnetic door hold-opens.

E. Coordinate door hold-opens with security requirements.

2.11 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 NETWORK COMMUNICATIONS

A. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

2.14 SYSTEM PRINTER

A. Printer shall be listed and labeled as an integral part of fire-alarm system.

2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing control/monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

D. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

E. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

K. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

N. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph wind load with a gust factor of 1.3 without damage.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in ¾" EMT minimum.

C. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated HVAC duct systems.
4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.
8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 27 0553 "Identification for Communications Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Architect, authorities having jurisdiction, and Owner.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.
    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283100

SECTION 31 10 00 | SITE CLEARING

PART1 GENERAL

1.0I SCOPE OF WORK

A. Furnish all labor, materials , equipment and incidentals necessary to perform all excavation work and grading; place and compact backfill and fill; and dispose of unsuitable , waste and surplus materials as shown on the Drawings or as directed by the OWNER, and as specified herein. The work shall include, but not necessarily be limited to; excavation for channel relocation, cap materials , and erosion control; all backfilling and fill; embankment and grading; disposal of waste and surplus materials; and all related work such as sheeting, bracing and pumping.

B. Furnish and install temporary excavation support systems, including sheeting, shoring and bracing, to insure the safety of personnel and protect adjacent structures, piping, etc. , in accordance with federal, state and local laws, regulations and requirements.

C. Temporary Erosion and Sediment Control is included in Section 603 of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Construction, 20I9 edition, as may be amended.

1.02 SUBMJTTALS

A. Submit the proposed methods of construction, including excavation, excavation support systems designs, backfilling and filling, and compaction for the various portions of the Work. Excavation support system designs shall be prepared by a licensed professional ENGINEER, registered in the State of New Mexico, having a minimum of five years of professional experience in design and construction of excavation support systems. Review will be for information only. CONTRACTOR shall remain responsible for adequacy and safety of construction means, methods, and techniques.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D698 - Standard Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures Using 5.5 lb. (2.49 kg.) Rammer and 12-in (305 mm) Drop.

2. ASTM D1557 - Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures , Using l O lb. (4.54 kg.) Rammer and 18-in (457 rnm)Drop.

3. ASTM 02487 - Standard Test Method for Classification of Soils for Engineering Purpose-s.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03 QUALITY ASSURANCE

A. OWNER shall employ a commercial testing lab in-place density tests to verify suitability of the existing subgrade soils at the bottoms of excavations.

l.04 EXCAVATION BELOW GRADE

A. Excavation shall be accomplished by methods which preserve the undisturbed state of the subgrade soils. Excavation equipment shall be satisfactory for carrying out the work in accordance with these Specifications. In no case shall the earth be plowed, scraped, or dug with machine1y so near to the finished subgrade as to result in excavation of, or disturbance of, material below finished subgrade.

During final excavation to subgrade level, take whatever precautions are required to prevent disturbance and remolding. Material which has been soft or loose or otherwise unsatisfactory to support the structure as a result of the excavation operation shall be removed and replaced as specified below. Compact subgrade to at least 95 percent of maximum density obtainable by ASTM D-698, remove all boulders in excess of eight (8) inches at the subgrade surface. The ENGINEER, will be the sole judge as to whether the work has been accomplished satisfactorily.

B. When the excavation has reached prescribed depths, the ENGINEER shall be notified and he will inspect conditions. If materials and conditions are not satisfactory to the ENGINEER, the ENGINEER will issue instructions as to the procedures to be taken.

1. If the bottom of the excavation is taken below the limits shown on the Drawings, specified or directed by the ENGINEER , it shall be refilled at the CONTRACTOR's expense with concrete, 8-inch layers of compacted structural fill placed and compacted with acceptable material. The type of material to be used shall be the ENGINEER' s option.

2. If the CONTRACTOR does not control surface runoff to maintain a firm and dry subgrade, or fails to postpone final excavation immediately above the subgrade until shortly before placing new work, or otherwise fails or neglects to conduct the excavation work properly so the surface of the subgrade is in proper condition prior to construction, the CONTRACTOR shall remove the unsuitable material and replace it at his own expense with acceptable material. The condition of the replaced subgrade shall be acceptable to the ENGINEER before any work is placed thereon.

3. If the subgrade is in its undisturbed natural condition, at or below the normal grade of the excavation as indicated on the Drawings is unsuitable for foundations, it shall be removed to such depth and width as may be required and be replaced with suitable material all as directed by the ENGINEER. If additional costs are involved, adjustments to the Contract will be made on the basis of prices agreed upon by the OWNER and CONTRACTOR in accordance with the provisions of the Contract Documents.

C. All excavations for pipes shall be backfilled with structural fill compacted as specified or encased in concrete.

D. Where it is impractical to use large equipment for compaction or when such methods, in the opinion of the ENGINEER, are disturbing the surrounding natural subgrade, the fill shall be placed using hand-operated mechanical compactors. The lift thickness shall not exceed six (6) inches measured before compaction when hand-operated equipment is used.

PART 2 PRODUCTS NONE - *NIA*

2.01 MATERIALS

A. Fill Material: **As specified per Soils Report, Section 31 01 00 - Grading; As specified in Section 31 23 23 - Fill and Backfill;**

PART 3 EXECUTION

3.01 SITE CLEARING

A.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding sedimentation of public waterways or storm sewers, or other pollution.

3.02 Existing Utilities and Built Elements

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.

B. Do not begin clearing until vegetation to be relocated has been removed.

C. Do not remove or damage vegetation beyond the **limits indicated on drawings.**

D. Install substantial, highly visible fences **at least 3 feet high at vegetation removal limits.**

E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.

1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
2. Sod: Re-use on site if possible; otherwise treat as specified for other vegetation removed.

G. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations , replace at no cost to **The Owner.**

3.04 DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 31 22 00 | GRADING

PART1 GENERAL

1.01 SECTION INCLUDES

A. Removal **and storage** of topsoil.

8. Rough grading the site **for site structures, building pads, and parking areas.**

C. **Replacement of topsoil and finish grading.**

1.02 RELATED REQUIREMENTS

A. Section **3110 00**- **Site Clearing.**

8. Section **31 23 16** - **Excavation.**

C. Section **31 23 16.13** - **Trenching: Trenching and backfilling for utilities.**

D. Section **31 23 23** - **Fill: Filling and compaction.**

1.03 SUBMITTAL$

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with **NMDOT Standard Specification for Highway and Bridge Construction 2019 Edition**

1. Maintain **one copy on site.**

PART 2 PRODUCTS

2.01 MATERIALS

A. Top soil excavated on site and local borrow material.

1. Graded.

2. Free of roots, rocks larger than **½ inch subsoil, debris, large weeds, and foreign matter.**

8. Other Fill Materials: See Section **31 23 23.**

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

8. Stake and flag locations of known utilities.

C. **Locate, identify, and protect from damage above and below grade utilities.**

D. Protect site features to remain, including but not limited to **bench marks and survey control points from damage by grading equipment and vehicular traffic.**

3.03 ROUGH GRADING

A. Remove topsoil from entire site, **without mixing with foreign materials.**

8. Do not remove topsoil when wet.

C. Remove subsoil from **areas to be further excavated.**

D. Do not remove wet subsoil **unless it is subsequently processed to obtain optimum moisture content.**

E. See Section **31 23 23 for filling procedures.**

G. **Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.**

3.04 SOIL REMOVAL AND STOCKPILING

A Stockpile top soil to be re-used on site; remove remainder from site.

B. Stockpiles: Use areas designated on site; pile depth not to exceed **8 feet protect from erosion.**

3.05 FINISH GRADING

A Before Finish Grading:

1. Verify building and trench backfilling have been inspected.
2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of ½ **inch in size. Remove soil contaminated with petroleum products.**

C. Where topsoil is to be placed, scarify surface to depth of **3 inches.**

D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of § **inches.**

E. Place topsoil in areas indicated.

F. Place topsoil thickness **as indicated.**

G. Place topsoil during dry weather.

H. Remove roots, weeds, rocks, and foreign material while spreading.

I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

3.06 FIELD QUALITY CONTROL

A See Section **31 23 23 for compaction density testing.**

3.07 CLEANING

A Remove unused stockpiled **topsoil. Grade stockpile area to prevent standing water.**

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 23 16 | EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, site structures, and utilities within the building, and general sitework.

B. Trenching for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Document: Geotechnical report, bore hole locations and findings of subsurface materials.

B. Section **31 23 03** Fill materials, filling, and compacting.

1.03 PROJECT CONDITIONS

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

PART 3 EXECUTION

2.01 EXAMINATION

A. Verify that survey bench mark and intended elevation for the work are as indicated.

2.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section **31 23 23** for additional requirements.

C. Locate, identify, and protect utilities that remain and protect from damage.

D. Notify utility company to remove and relocate utilities.

E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, and from excavating equipment and vehicular traffic.

F. Protect plants, lawns, and other features to remain.

2.03 EXCAVATING

A. Excavate to accommodate new structures and construction operations.

B. Notify DPS Architecture of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Preparation for Piling Work: Excavate to working elevations.

D. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

E. Do not interfere with 45 degree bearing splay of foundations.

F. Cut utility trenches wide enough to allow inspection of installed utilities.

G. Hand trim excavations. Remove loose matter.

H. Remove lumped subsoil, boulders, and rock up to ⅓ cu yd measured by volume.

I. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.

J. Grade top perimeter of excavation to prevent surface water from draining into excavation.

K. Remove excavated material that is unsuitable for re-use from site.

L. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00.

M. Remove excess excavated material from site.

2.04 FIELD QUALITY CONTROL

A. Inspection and testing will be performed as directed by the Project Engineer.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at the expense of the Contractor.

2.05 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain solid stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION

SECTION 31 23 23 | FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling , backfilling, and compacting for building volume below grade, footings, slabs-on-grade, paving, site structures, and utilities within the building.

B. Backfilling and compacting for utilities outside the building to utility main connections.

C Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02 DEFINITIONS

A. Satisfactory Materials: Materials classified in accordance with ASTM D2487 as SW, SP, SM, SC, SW-SM, SW-SC, SP-SM, SP-SC, SC-SM, GW, GP, GM, GC, GW-GM, GW-GC, GP-GM and GP-GC and free of roots and other organic matter, trash, debris, frozen materials and stones larger than 3-inches in any dimension for select fill or 6 inches in any dimension for common fill, and as further defined in the project Geotechnical report, can be considered satisfactory.

B. Unsatisfactory Materials: Materials that are not in accordance with the requirements for satisfactory materials are unsatisfactory. In addition, materials, which include man-made fills, refuse or stabilized backfills from previous construction are unsatisfactory.

C. Sub-excavation: Excavation of existing materials to specified depths or elevations below the bottom footings or foundations for the purpose of removing unsound or undesirable soil materials for replacement with select fill or other specified fill material.

D. Compaction: Degree of compaction is a percentage of maximum density obtained by the test procedure described in ASTM D1557 and is abbreviated in this section as a percent of laboratory maximum density.

E. Proof rolling: Compaction method using a 10 ton steel or pneumatic wheeled roller to locate and identify weak or compressible zones in exposed sub-grade soils. For this specification proof rolling will include a minimum of ten (10) passes with an approved roller and must be observed and approved by the presence of the Project Engineer.

1.03 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)/American Society for Testing and Materials (ASTM).

1. ANSI/ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ANSI/ASTM D1557 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 10 lb (4.54 Kg) Rammer and 18 inch (457mm) Drop.
3. ASTM D 2487 – Classifications of Soils for Engineering Purposes (Unified Soil Classification System).
4. ASTM D2922 – Test Methods for Density of Soil-Aggregate Mixtures in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 – Test Methods for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
6. ASTM D4318 – Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.04 SUBMITTALS

A. Submit and obtain approval prior to beginning earthwork operations:

1. Name and location of source(s) proposed for imported soils and aggregate materials.
2. Certified test reports and analysis from identified proposed source, certifying that the soils and aggregate materials proposed for use on the project conform to the specified requirements.

3. Imported materials to be supplied from the same source throughout the work. Change of source will require submittal of certified test reports as per 2. above, for the proposed soil materials and the Engineer's approval.

B. During earthwork operations:

1. Certified test reports and analysis for all tests conducted in accordance with 3.05, Field Quality Control, this Section.

C. 15 days prior to Final Acceptance:

1. Accurately record, on a set of the construction plans, actual locations of all existing improvements, monuments and improvements remaining as well as any changes to locations, numbers, etc to the new improvements, structures, etc. as may have been approved during construction.
2. Actual locations to be shown with horizontal dimensions, elevations, inverts and slope gradients.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Select Granular Material

1. General Requirements:

Select granular material consist of materials classified as GW, GP, SW, SP, by ASTM D2487. The liquid limit of such material must not exceed 35 percent when tested in accordance with ASTM D4318. The plasticity index must not be a greater than 12 percent when tested in accordance with ASTM D4318, and not more than 35 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D1140.

2. Non-expansive Fill:

Non-expansive fill shall consist of satisfactory materials free from rocks greater than 1" in diameter in any direction. The liquid limit of such material shall not exceed 35 percent and the plasticity index shall not be greater than 12 percent or less than 4 percent when tested in accordance with ASTM D4318. The sodium sulfate content shall not exceed 0.2 percent by dry weight of soil and soil solubility shall be less than 1.5 percent. The select fill shall be placed in 8" loose to 6" maximum compacted lifts with each lift tested and accepted prior to placement of the next lift. The select fill should be moisture conditioned to +/- 2% of optimum moisture then compacted to a minimum of 95% of maximum dry density as determined by a Modified Proctor (ASTM D1557).

3. CAPILLARY WATER BARRIER

Provide capillary water barrier of clean, poorly graded crushed rock or crushed gravel placed beneath a building slab with a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Gradation of capillary water barrier shall meet gradation requirements of ASTM C33 coarse aggregate Size 67.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. Verify sub-drainage, damp-proofing, or waterproofing installation has been inspected.

3.02 PREPARATION

A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill material as approved by the Engineer.

C. Compact subgrade to density as specified in the project plans and specifications.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

E. Identify required lines, levels, contours, and datum.

F. Notify public utility authorities in accordance with City regulations and coordinate verification of existing utilities locations. Contractor shall remain responsible for the location and work in and around any utilities.

G. Confirm, stake and flag locations of known utilities.

H. Coordinate with utility companies, the removal or relocation of utility lines or facilities designated to be relocated on the drawings.

I. Protect above the below grade utilities designated to remain or any other utilities within the site.

J. Protect plants and other features designated to remain as part of final landscaping.

K. Protect benchmarks, existing structures, fences, paving, and curbs and other improvements on the site and along the access route, designated to remain, from excavating equipment and vehicular traffic.

L. The Contractor shall remain responsible for any damage to existing structural improvements within the site or adjoining properties that may be affected by the Contractor’s operation. The Contractor shall hold harmless, the Owner and Engineer from any damage or injury caused by the Contractor’s operations.

3.03 FILLING

A. Fill to contours and elevations indicated using unfrozen materials.

B. Fill up to subgrade, finish grade elevations unless otherwise indicated.

C. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth

D. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.

E. Slope grade away from building as shown on the Project site grading plan, unless noted otherwise. Make gradual changes. Blend slope into level areas.

F. Remove all roots, brush, heavy sods, heavy growth of grass, decayed vegetable matter, rubbish, and other unsatisfactory materials from areas to receive fill materials.

G. Existing slopes greater than four horizontal to one vertical which are to receive fill shall be plowed, stepped or broken up in such manner that the fill material will bond with the existing surface.

    1. Prepared surfaces that are to receive fill shall be scarified, wetted or dried, as required, to obtain specified moisture content and compacted to 95% of maximum density.

H. Fills and embankments shall be constructed in the locations and to lines and grades indicated. Completed fill will conform to shapes indicated by plan and typical sections and contours. Make grade changes gradual. Blend slope into level areas.

I. Place fill materials in continuous horizontal layers of 8 inch (6-inch, where hand held compaction equipment is to be used for compaction) loose depth for the full width of the cross section and compacted to 95% of maximum density or to the density shown on the plans.

J. Maintain moisture content to within plus or minus 2 percent of optimum moisture content as determined from laboratory tests of the fill materials.

K. Do not backfill over porous, wet, frozen or spongy subgrade surface.

L. Use placement methods that will not disturb or damage existing structures or other work.

1. Backfill adjacent to structures shall be placed and uniformly compacted in such manner as to prevent wedging action or eccentric loading upon or against the structures.

M. Finished graded surfaces of all areas covered by the project, including excavated and filled sections and adjacent transition areas, shall be uniformly smooth-graded.

1. Slope grade away from buildings at minimum slope of ¼-inch per foot (2%) for minimum of 10-feet unless noted otherwise.

N. Remove surplus fill materials and unacceptable materials from the site and dispose of at acceptable disposal sites.

O. Over-excavation beyond the limits and depths required by the Contract Documents shall be replaced to the specified lines and grades at no additional cost to the Owner with select fill or learn concrete or other material approved, in writing, by the Engineer.

3.04 TOLERANCES

A. Top Surface of General Filling: Plus or minus 0.10 foot from required elevations.

B. Top Surface of Filling Under Paved Areas, 0.10 foot Plus or minus 1 inch from required elevations.

3.05 FIELD QUALITY CONTROL

A. Inspection and testing will be performed as directed by the Project Engineer.

B. If tests indicated Work does not meet specified requirements, remove Work, replace and retest at the expense of the Contractor.

3.06 CLEANING

A. Leave unused materials in a neat, compact stockpile.

B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 32 11 23 | AGGREGATE BASE COURSE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnishing, hauling, and placing Aggregate base course.

B. Paving aggregates.

1.02 REFERENCE STANDARDS

A. NMDOT Standard Specifications for Highway and Bridge Construction 2019 Edition, Section 303-Base Course

B. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; **2006**.

C. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort **(**12,400 ft-lb f/ft3 (600 **kN-m/m3)); 2007.**

D. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; **2007**.

E. ASTM D1557 – Standard Test Methods for laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb f/ft3 **(**2,700 kN **m/m3)); 2009.**

F. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2010.

G. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth**); 2005**.

H. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.

I. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soi/-Aggregate by Nuclear Methods (Shallow Depth); 2010

1.03 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When aggregate materials need to be stored on site, locate stockpiles where **designated** by **the Engineer**

1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
2. Prevent contamination.
3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS

Base course shall be composed of materials consisting of crushed stone, crushed or screened gravel, caliche, sand, or a combination of such materials. Base course shall be free from vegetable matter and all other deleterious materials, including silt and clay balls.

Sieve Sizes	I-B	II-B
2"		
1-1/2"		
1"	100	100
3/4"	80 -100	85-100
3/8"	-	-
No. 4	30-60	40-70
No.10	20-45	30-55
No. 200	3-10	4-12
2FF*	50% or	50% or
	more	more

**Fractured faces tests shall be performed on the material retains on the number 4 sieve. A face shall be counted as fractured whenever one-half{½) or more of the surface, when viewed normal to the face, is fractured*

Type I-B, Type II-B aggregated shall have a percent wear of fifty (50) or less at 500 revolutions when tested in accordance with AASHTO T 96 and the coarse aggregate shall have a soundness loss of eighteen (18) or less when tested in accordance with AASHTO T-104 using magnesium sulfate solution and a test duration of five (5) cycles. For caliche aggregates the soundness loss shall be twenty two (22) or less. The liquid limit shall be twenty five (25) or less and the plastic index shall be six (6) or less.

Samples will be tested to determine the quality of the aggregate in terms of Los Angeles wear and soundness loss of aggregate

Testing will be done by an approved Independent Testing Laboratory (ITL). Test will take a minimum of fifteen (15) working days to accomplish.

Contractor shall submit samples of the aggregate for source approval. If testing indicates the material meets, the Contractor may begin crushing operations from the material source.

For commercial sources, the Contractor may maintain an ongoing approval by submitting samples on a semiannual basis in accordance with procedures established.

The subgrade, subbase, or base course upon which the base course is to be placed shall be cleaned of all loose and deleterious materials and shall be free from frozen material.

Top six (6) inches shall meet the density requirements for Subgrade Preparation, Mixing and Placing, immediately prior to placing the base course.

At the request of the Engineer the subgrade shall be proofrolled with a thirty (30) ton roller and soft areas corrected.

2.02 SOURCE QUALITY CONTROL

A Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance **before delivery to site.**

B. If tests indicate materials do not meet specified requirements, change material and retest.

C. Provide materials of each type from same source throughout the work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

B. Verify substrate has been inspected gradients and elevations are correct and is dry.

3.02 PREPARATION

A Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

A. Spread aggregate over prepared substrate to a total compacted thickness of **6" inches where applicable.**

8. Under **Bituminous Concrete Paving**

1. Place **aggregate base course to a total compacted thickness of 6" inches.**

2. Compact to **95 percent of maximum dry density.** (ASTM D1557)

C. Under **Portland Cement Concrete Paving** 4" of base course material is required.

D. Level and contour surfaces to elevations and gradients indicated.

E. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

G. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

H. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maxim um variation of **0.10 feet measured with 10 foot straight edge.**

8. Scheduled Compacted Thickness: Within **0.05 feet.**

C. Variation From Design Elevation: Within **0.05 feet.**

3.05 FIELD QUALITY CONTROL

A. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D2922.

8. **Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557.**

C. If tests indicate work does not meet specified requirements, **remove work, replace and retest at no additional cost to the owner.**

D. Frequency of Tests as per the Engineer.

3.06 CLEANING

A. Leave unused materials in neat, compact stockpile.

B. Remove unused stockpiled materials, leave area in clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 32 12 16 | ASPHALT PAVING

PART1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

B. Single course bituminous concrete paving.

C. Double course bituminous concrete paving.

D. Surface sealer.

1.02 REFERENCE STANDARDS

A. Al MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; The Asphalt Institute:1994.

B. ASTM D2172 - Standard Specification for Quantitative Extraction of Bitumen from Bituminous Paving Mixture.

C. ASTM D2041 - Standard Specification for Theoretical Maximum Specific Gravity for Bituminous Paving Mixture:2003.

D. ASTM D5444 - Standard Specifications for Mechanical size analysis of Extracted Aggregate

E. ASTM D6926 - Standard Practice for Preparation of Bituminous Specimens using Marshall Apparatus; **2010**

1.03 QUALITY ASSURANCE

A. The owner will accept the constructed product based on the Engineers inspection and on Laboratory testing for conformance with the design specifications.

B. Mixing Plant: Conform to State of New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Construction, 2019 Edition Highways standard.

C. Obtain materials from same source throughout.

1.04 FIELD CONDITIONS

A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F or surface is wet or frozen.

B. Place bitumen mixture when temperature is not more than 15 degrees F below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.01 MATERIALS

All materials shall be tested in accordance with applicable AASHTO methods or other test procedures designated by the ENGINEER. All questions arising as to interpretation of test procedures shall be decided by the ENGINEER. Material that is improperly graded or segregated, or fails to meet the requirements herein provided, shall be corrected or removed and disposed of immediately as directed by the Engineer, at the Contractor's expense.

A. Type I. Each fraction of Type I PMBP coarse aggregate shall have a percent wear of forty (40) or less at 500 revolutions when tested in accordance with AASHTO T 96 and the coarse aggregate shall have a soundness loss of fifteen (15) or less when tested in accordance with AASHTO T 104 using magnesium sulfate solution and a test duration of five (5) cycles. All material passing the No. 40 sieve shall be non-plastic. The amount of crushing shall be regulated so that at least seventy five percent (75%), by dry weight, of the plus No. 4 sieve material shall have a minimum of two (2) fractured faces. The combined aggregate shall have a minimum sand equivalent of forty five (45).

B. Fractured Faces. A face will be counted as fractured whenever one-half (½) or more of the surface, when viewed normal to the face, is fractured.

2.02 Production.

When producing aggregates for PMBP natural fines shall be removed by screening and stockpiled separately. The Contractor shall use as a minimum, the U.S. No. 4 sieves for this screening operation. The contractor may use a larger screen if needed to properly control the crushing and screening operation. The aggregate retained on the scoping screen sieve shall then be crushed, separated and stockpiled as specified herein. Crushing operations shall be regulated in a manner that produces material within the specified gradation band.

When producing aggregates for PMBP the crushed material shall be separated into at least two (2) stockpiles of fine and coarse aggregates.

The coarse aggregate shall have not more than four percent (4%) passing the U.S. No. 10 sieve. In the case of a wet pit, when screening becomes difficult, the Engineer may authorize the coarse aggregate passing the U.S. No. 10 sieve *to* be increased to a maximum often percent (10%). The fine aggregate shall have no more than five percent (5%) of the material retained on the separating screen The Separating screen shall be that screen where separation between coarse and fine aggregate occurs depending on the material.

2.03 Combining.

When the crushed materials from the stockpiles are combined, the product of such combination shall meet the gradation requirements. In order to meet the specified mix design criteria, blending sand may be added up to a maximum of twenty percent (20%). The actual percentage will be determined based on tests performed by the Contractor. The Contractor shall furnish blending sand from what-ever source necessary to meet mix design gradation requirements.

2.04 Acceptance of Aggregate.

The liquid limit, sand equivalent and fractured face count of PMBP aggregate will be determined from representative samples taken after the aggregate materials have been blended and prior to mixing with bituminous material. The test results from these samples will be the basis for acceptance of such aggregate. The Engineer may sample and test the aggregate at any time during production or stockpiling.

The mix design proposal shall contain, as a minimum, the following:

1. The name and address of the testing organization and the person responsible for the testing.
2. The specific location(s) of the source(s) of aggregate and blending sand.
3. The supplier, refinery and type of asphalt cement, and the source and type of mineral filler and the percentage of each to be used.
4. The mineral aggregate gradation in each stockpile.
5. The proposed mix design gradation.
6. The results of all testing, determinations, etc. such as: Specific gravity of each component, water absorption, sand equivalent, loss on abrasion (LA wear), soundness loss, fractured faces, immersion compression results, Marshall Stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density.

2.05 Mix Temperature Requirements.

The temperature of the bituminous mixture at discharge from the mixer shall not exceed 300°F and shall not be less than 250°F. When polymer modified asphalts are used the maximum temperature shall not exceed 350°F. The mixing temperature shall be as directed by the Engineer, and the temperature shall be maintained within a range of plus or minus twenty degrees (20°}F.

2.06 Haul Equipment.

Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of commercial agent to prevent the mixture from adhering to the bed. If diesel fuel is used it shall be applied to the truck bed with a fine spray fogging device with the truck bed in the maximum raised position and allowed to drain before the bed is lowered. There shall be no puddles of diesel fuel or material from the previous load allowed in the truck bed. Bituminous material place in truck beds with puddle or draining diesel fuel shall be wasted at the Contractor's expense.

Each truck shall have a cover of canvas or other suitable material of sufficient size to protect the mixture from the weather to be used as directed by the Engineer.

2.07 Pavers.

Pavers shall be self-contained, self-propelled units, provided with an activated screed or a strike-off assembly, heated if necessary, and capable of spreading and finishing courses of PMBP material to the widths and thickness as specified in the contract.

Pavers shall be operated at a speed no greater than three (3) MPH. Materials introduced in front of the screed shall maintain a consistent depth to avoid variation in pressure on the screed. The auger box shall be maintained at 1/3 to 2/3 full.

Pavers shall be equipped with a receiving hopper sufficient capacity to effect a uniform spreading operation. The hopper shall be equipped with a distribution system capable of maintaining a uniform amount of mixture in front of the screed.

The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture. The screed shall be adjustable or both height and crown and shall be equipped with a controlled heating device.

The screed or strike-off assembly shall produce a finished surface of an even and uniform texture for the full width being paved without tearing, shoving or gouging the mixture. Screeds shall include any strike-off device operated by tamping or vibrating action.

The bituminous paver shall be equipped with an automatic leveling device controlled from an external guide. The initial pass for each course shall be made using a paver equipped with a forty (40) foot minimum external reference, except that this requirement will not apply when PMBP is placed adjacent to Portland cement concrete pavement or when short lengths of PMBP placement is required. Subsequent passes and passes adjacent to PCCP shall utilize a matching device of one (1) foot minimum length riding on the adjacent lay.

2.08 Compaction Equipment.

Equipment proposed for use in the compaction of PMBP shall be approved by the Engineer prior to use. All rollers shall be self-propelled, in good condition and capable of reversing without backlash. One (1) roller shall be either a steel wheel vibratory roller weighting a minimum of six (6) tons or a smooth faced wheel roller of two (2) axle or three (3) axle tandem design weighting a minimum of ten (10) tons. The other roller shall be a self-propelled pneumatic tired roller so constructed that the average ground contact pressure may be varied between forty (40) and ninety (90) pounds per square inch.

2.09 Placement Operations.

The asphalt concrete mixture shall be placed on the approved surface, spread and struck off to the grade and elevation established. It shall be spread and compacted in layers as shown on the plans or as directed by the Engineer. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

The subgrade, base course or BTB upon which the PMBP is to be placed shall be cleaned of all loose material or other deleterious materials prior to placement of the PMBP. These surfaces shall be free of frozen material and the moisture and density requirements of the applicable Section shall be met prior to placement of the new PMBP.

On areas there irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be dumped, spread and leveled to give the required compacted thickness.

2.10 Temperature & Weather Limitations.

PMBP shall not be placed on wet or frozen surfaces; when the ambient temperature is below forty five degrees (45°)F; when the chill factor is below thirty five degrees (35°)F; or when weather conditions otherwise prevent the proper handling and finishing of the PMBP.

2.11 Placement Temperature.

The Engineer will determine a minimum placement temperature within a range from 220°F to 300°F. When polymer modified asphalts are used the maximum temperature shall be 350°F. The established placement temperature, which is measured immediately behind the laydown machine, shall not vary more than plus or minus twenty degrees (20°)F from that established by the Engineer.

2.12 Compaction.

Immediately after the bituminous mixture has been spread, struck-off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted.

The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density. Rolling operations shall not disturb the typical section placed by the paver.

Rollers shall be operated at speeds less than three (3) MPH and slow enough to minimize the displacement of the bituminous mixture. The use of equipment which results in excessive crushing of aggregates will not be permitted. At least two (2) rollers shall be used for compaction. Both steel faced and pneumatic rollers are required. If the pneumatic roller leaves marks that require a final rolling, additional passes with a static wheel roller will be required to remove the marks.

Any displacement occurring as a result of the reversing of direction of a roller, or from other causes, shall be corrected immediately by the use of rakes and addition of fresh bituminous mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted. Diesel fuel or other petroleum diluents are not acceptable.

Along forms, curbs, headers, walls and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers. On depressed areas, a trench roller or cleated compression strips under the roller may be used to transmit compression to the depressed area.

Mixtures which become loose, broken, mixed with dirt, segregated or are defective shall be removed replaced with fresh hot bituminous mixture, and compacted to conform with the surrounding area, at the Contractor's expense. Areas showing excess or deficiency of bituminous material shall be corrected immediately as directed by the Project Manager.

2.13 FIELD QUALITY CONTROL

A. Provide field inspection and testing. Take samples and perform tests in accordance with **quality control requirements to be established by Engineer.**

2.14 PROTECTION

A. Immediately after placement, protect pavement form mechanical injury for **one day or until surface temperature is less than 140 degrees F.**

END OF SECTION

SECTION 32 13 13 | CONCRETE PAVING

PART1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks, stair steps, curbs, gutters, parking areas, and valley curbs.

1.02 REFERENCE STANDARDS

A. NMDOT Standard Specifications for Highway and Bridge Construction, 2019 Edition "Section 450 - Portland Cement Concrete Pavement"

B. ACI 2211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and **Mass** Concrete; American Concrete Institute International:1991 **(Reapproved 2002).**

C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; **2000.**

D. ACI 305R - Hot Weather Concreting; American Concrete Institute International; **2010.**

E. ACI 306R - Cold Weather Concreting; American Concrete Institute International; **2010.**

F. ASTM C33 - Standard Specification for Concrete Aggregates; **2011.**

G. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; **2010.**

H. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; **2011**

I. ASTM C150 - Standard Specification for Portland Cement; **2011**

J. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 201Ob .

K. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete; **2010a.**

L. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; **2007.**

M. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; **2010a.**

N. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; **2008.**

0. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (non-extruding and Resilient Bituminous Types); **2004a (Reapproved 2008).**

1.03 SUBMITTAL$

A. Product Data: Provide data on concrete mix designs proposed for usage on this Project Site Mix designs are to be approved by the Engineers prior to usage.

B. Design Data: Contractor ls advised to review the Project plans for pavement thickness, design strengths, and typical details.

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

A. Comply with applicable requirements of NMDOT Standard Specifications for Highway and Bridge Construction, 2019 Edition Section 450.

B. Design paving for parking and light duty commercial vehicles.

C. Concrete Sidewalks: **3,000 psi 28 day concrete, 4 inches thick 5%-7% air entrainment, 4" maximum slump.**

D. Parking Area Pavement: **4,000 psi 28 day concrete, 6 inches 5%-7% air entrainment, 1"-3" slump.**

2.02 FORM MATERIALS

A. Form Materials Conform to ACI 301.

B. Wood or Steel form material profiled to suit conditions.

C. Join Filler: Preformed non-extruding bituminous type (ASTM D1751).

1. Thickness: ½ inch.

2.03 CONCRETE MATERIALS

A. Obtain cementitious materials from same source throughout.

8. Cement: ASTM C150 **Normal Type** 1-11 L. A.

C. Fine and Coarse Mix Aggregates: ASTM C33 Maximum aggregate size# 57.

D. Fly Ash: ASTM C618, Class **C or F**.

E. Water: Clean, and not detrimental to concrete.

F. Fiber Reinforcement: Alkali-resistant glass fibers; Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture.

G. Air Entrainment Admixture: ASTM C260.

H. Chemical Admixtures: ASTM C494/C494M, Type A - **Water** Reducing

2.04 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

8 . Concrete Strength: Establish required average strength for **each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.**

1. For trial mixtures method, employ independent testing agency acceptable to **Lydick Engineers and Surveyors, Inc. for preparing and reporting proposed mix designs.**

C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer

D. Fiber Reinforcement: Add to mix at rate of **1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.**

E. Concrete Properties:

1. Compressive Strength, when tested in accordance with ASTM C39/C39M at **28 days.**

2. Fly Ash Content: Maximum 20% of cementitious materials by weight.

3. Cement Content: Minimum 517 lb per cubic yard.

4. Water-Cement Ratio: Maximum **0.45 percent by weight.**

5. Total Air Content: **5%-7% determined in accordance with ASTM C173/C173M.**

6. Maximum Slump: **4 inches.**

7. Maximum Aggregate Size: **#57.**

2.05 MIXING

A. Transit **Mixers:** Comply with **ASTM C94/C94M.**

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify compacted **subgrade is acceptable and ready to support paving and imposed loads.**

B. Verify gradients and elevations of base are correct.

3.02 PREPARATION

A. Moisten-subgrade to minimize absorption of water from fresh concrete.

B. Coat surfaces of catch **basin frames with oil to prevent** bond **with concrete pavement.**

C. Notify **Lydick Engineers and Surveyors, Inc. minimum 24 hours prior to commencement of concrete operations.**

3.03 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.04 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than **40 degrees F, or surface is wet or frozen.**

3.05 PLACING CONCRETE

A. Coordinate installation of snow melting components.

B. Place concrete **in accordance with ACI 304R.**

C. Place concrete continuously over the full width of the panel and between predetermined construction joints. **Do not break or interrupt successive pours such that cold joins occur.**

3.06 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Place **3/8 inch** wide **expansion** joints at **60 foot intervals and to separate paving from vertical surfaces and other components.**

1. Form joints with joint filler extending from bottom of pavement to within **½ inch of finished surface. All expansion joints in the concrete pavement, curb and gutter, and sidewalks are to be sealed.**

C. Provide a **complete jointing plan to the Engineer for approval prior to concrete placement.**

D. Provide keyed joints as indicated.

E. Saw cut contraction joints **3/16 inch wide at optimum time after finishing. Cut 1/3 into depth of slab. For concrete curb and gutter contraction joints should be placed at 15 feet to 20 feet intervals. For concrete sidewalks, the contraction joints should be placed at five (5) foot intervals.**

3.07 FINISHING

A. Parking Area Paving: **Light broom, texture perpendicular to pavement direction.**

B. Sidewalk Paving: **Light broom, texture perpendicular to direction of travel.**

C. Curbs and Gutters: **Light broom, texture parallel to pavement direction.**

D. Inclined Vehicular Ramps: **Broomed perpendicular to slope.**

E. Place **curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.**

3.08 FIELD QUALITY CONTROL

A. **Lydick Engineers & Surveyors, Inc.** will perform all field quality control tests.

1. Submit proposed mix design of each class of concrete to Robert C. Lydick, P.E. for review prior to commencement of concrete operations.

2. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

3.09 PROTECTION

A. Immediately after placement, protect pavement form premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit **vehicular traffic over pavement for 7 days minimum after finishing.**

END OF SECTION

SECTION 32 17 23.13 | PAINTED PAVEMENT MARKINGS

PART1 GENERAL

1.01 SECTION INCLUDES

A Parking lot markings, including **parking bays. crosswalks . arrows. handicapped symbols, curb markings.**

B. Roadway lane markings and crosswalk markings.

C. "No Parking" curb painting.

1.02 REFERENCE STANDARDS

A FS TT-B-1325 - Beads (Glass Spheres); Retro-Reflective; **Rev. D. 2007.**

8. FHWA MUTCD- Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration; http://mutcd.fhwa.dot.gove ; **current edition.**

1.03 SUBMITTALS

A Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

8. Certificates: Submit for each batch of paint **and glass beads stating compliance with specified requirements.**

1.04 DELIVERY, STORAGE, AND HANDLING.

A Deliver paint in containers of at least **5 gallons or accompanied by batch certificate.**

B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment **or accompanied by batch certificate.**

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.05 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS

A. Line and Zone Marking Paint: MPI No. 97 Latex Traffic Marking Paint; **color as indicated; white, yellow, white and yellow.**

1. Parking Lots: Yellow.
2. Handicapped Symbols: Blue.

B. Reflective Glass Beads: FS TT-B-1325, Type I (low index of refraction), Gradation A (coarse, drop-on), **with silicone or other suitable waterproofing coating to ensure free flow .**

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify **Lydick Engineers of unsatisfactory preparation before proceeding.**

3.02 PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.

1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or combination of these methods.

2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement, by scraping, wire brushing, sandblasting, mechanical abrasion, or approved chemicals.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

3.03 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 **degrees** F or more than **95 degrees F.**

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.

1. Apply paint in one coat only.

2. Wet Film Thickness: **0.015 inch**, minimum.

3. Length Tolerance: Plus or minus **3 inches**.

4. Width Tolerance: Plus or minus 1/8 inch.

G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.

1. Mark the International Handicapped Symbol at indicated parking spaces.

2. Hand application by pneumatic spray is acceptable.

H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

A Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended bythe manufacturer.

D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method. Use equipment that is capable of completely removing painted markings 1/4" ± inch depth, and at least twice the width of the marking. Do not use non-reflective black removable marking tape or overpainting to remove the pavement marking.

F. Replace removed markings at no additional cost to **THE OWNER**.

END OF SECTION