PROJECT MANUAL
VOLUME 2

OCTOBER 20, 2020

VLK | ARCHITECTS

New Central Administration Building
EAGLE MOUNTAIN-SAGINAW ISD
FORT WORTH, TEXAS

VLK Project No.
1847.00

OWNER:

Eagle Mountain-Saginaw Independent School District
1200 Old Decatur Rd
Fort Worth, TX 76179

OWNER

Eagle Mountain-Saginaw Independent School District
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10/20/2020

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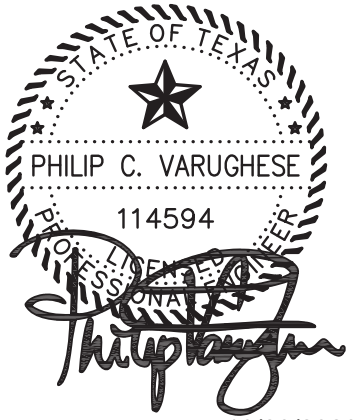

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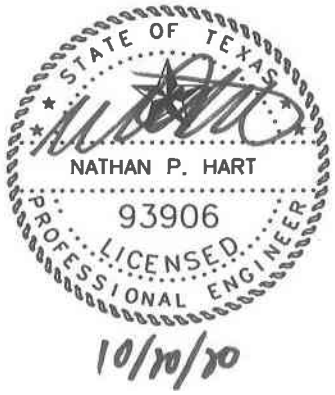

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COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Conditions of the Contract including the General Conditions, Supplementary Conditions, and Division One, apply to all work of this Division, whether attached or not.

B. The requirements specified in this Section shall be applicable to work specified in other Sections within this Division.

1.2 SCOPE OF WORK

A. All Division 21 sections of these specifications shall include all labor and material to complete the entire fire suppression systems as specified and shown on the Drawings. All work shall be fully compliant with NFPA 13, 14, 24 Owner’s Insurance Carrier and Local Authority having jurisdiction.

B. All work shown and specified shall be completely installed and connected by mechanics properly qualified to perform the work required. All work shall be left in a satisfactory operating condition as determined by the Owner and Owner's Representative.

C. Provide all services and perform all operations required in connection with, or properly incidental to, the construction of complete and fully operating systems with all accessories as herein specified and shown on the Drawings.

D. Refer to "Conditions of Work" in Division 1

1.3 QUALITY ASSURANCE

A. The manufacturer shall be a firm regularly engaged in the manufacture of fire protection equipment and accessories of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. The installer shall be a firm with at least two (2) years of successful installation experience on projects with fire protection equipment and piping similar to that required for this project.

1.4 GENERAL

A. The accompanying Drawings show diagrammatically the general routing and location of the various equipment items and the major interconnecting piping and equipment and backflow preventers, as required by local authority having jurisdiction, without showing exact details as to elevations, offsets, control lines, and other installation details. The Contractor shall carefully lay out his work to conform to the site conditions, to avoid obstructions, provide proper grading of lines and fully comply with NFPA 13, 14, 24, Owner’s insurance carrier and local authority having jurisdiction. Exact locations of outlets, apparatus, and connections thereto shall be determined by reference to the Drawings, reviewed Shop Drawings, including equipment drawings, and rough-in drawings, by measurements at the building, and in cooperation with work specified in other sections of these specifications. Minor relocations necessitated by the conditions at the site or directed by the Architect shall be made without any additional cost to the Owner.

B. These specifications and the accompanying Drawings are intended to describe and illustrate systems which will not interfere with the structures, which will fit into available spaces, and which will insure

complete and satisfactorily operating installations. Contractor shall coordinate the proper fitting of all material and apparatus into the building and shall prepare larger scale installation drawings for all critical areas, areas with limited working clearances, and areas of significant congestion requiring a higher level of coordination illustrating the installation of work specified in Division 21 in relation to all other portions of work specified in other Sections of these Specifications. Interferences with other portions of work, or the building structure, shall be corrected before any work proceeds. Should changes become necessary on account of the failure of the Contractor to comply with these stipulations, Contractor shall make all necessary changes at no expense to the Owner.

C. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted on the Drawings.

D. It is the intent of the Contract Documents to provide an installation complete and operational in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section, or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems and required to complete the installation.

E. Contractor sets forth that all personnel have the necessary technical training and ability; and that all work specified in this Division will be installed to the best standard of each trade, and will be complete and in good working order. If any of the requirements of the Drawings and specifications are impossible to perform, or if the installation when made in accordance with such requirements will not perform satisfactorily, report same to the Architect promptly after discovery of the discrepancy.

F. No extra compensation will be allowed for extra work or changes caused by failure to comply with the above requirements.

1.5 EXAMINATION OF THE SITE

A. Contractor shall visit the site, verify all items indicated on the Drawings or specified, and familiarize himself with the work conditions, hazards, grades, actual formations, soil conditions, points of connection, utility locations, and local requirements.

B. Contractor shall take these conditions into consideration, and the lack of specific information on the Drawings shall not relieve the Contractor of any responsibility.

C. All site visits shall be coordinated and scheduled with the Owner.

1.6 CUTTING AND PATCHING

A. Excessive cutting of the building structure, walls, floors, ceilings, roof, etc., will not be permitted. No structural member shall be notched or cut unless specifically shown on the Drawings, or unless such cutting is authorized by the Architect.

B. Provide for all holes or openings of proper size and shape as may be necessary for the proper installation of work specified in Division 21, consulting with the Architect regarding proper locations and sizes.

C. Where deemed necessary, and after consulting with the Architect, perform all cutting and patching required for the installation of piping, ductwork, etc. This shall include the cutting of concrete floors, concrete and tile floors, walls, ceilings, roofs, etc. It shall also include patching them as required to restore work to match existing finishes, following installation, testing, backfilling, insulation, etc.

D. Holes through concrete shall be drilled with "Mole", "Core-It', or other diamond point hole saw.

E. Refer to Division 01, Cutting and Patching.

1.7 CODE REQUIREMENTS

A. Contractor is required to comply with the requirements of all National, State, local codes and utility companies having jurisdiction and Owner’s Insurance Carrier. In no case does this relieve the Contractor of the responsibility of complying with the requirements of these specifications and Drawings where specified conditions are of higher quality than the requirements of the above specified offices. Where requirements of the specifications and Drawings are below the requirements of the above offices having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above offices and shall notify the Architect promptly.

B. Contractor shall comply with the requirements and standards set forth by, but not limited to, the following:

1. (NFPA) National Fire Protection Association.
2. (OSHA) Occupational Safety and Health Administration.
3. (NEC) National Electric Code.
4. Local Plumbing Code.
5. Local Building Code.
6. Local Mechanical Code.
7. Local Fire Code.

C. Contractor shall obtain all permits, inspections, and approvals as required by all authorities having jurisdiction. Fees and costs incidental to these permits, inspections, and approvals must be assumed and paid by the Contractor.

1.8 RECORD DRAWINGS

A. Contractor shall, during the execution of work, maintain a complete set of “Record Drawings” upon which all locations of equipment, ductwork, piping, and all deviations and changes in the work shall be neatly recorded for use in producing "As Builts" at Project Close- Out. This shall include the incorporation of all Supplemental Drawings issued during the Construction Period.

B. All “Record Drawings” shall be reviewed monthly during the Construction Period, along with the monthly Pay Application Request.

C. Refer to Division 01, Execution and Close-Out Requirements.

1.9 RECORDS AND INSTRUCTIONS FOR OWNER

A. Accumulate during the job's progress the following sets, in triplicate, in accordance with the provisions of Division 01, Execution and Close-Out Requirements:

1. Warranties and guarantees and manufacturer's directions on equipment and material covered by the Contractor.
2. Equipment and fixture brochures, wiring diagrams, and control diagrams.
3. Copies of reviewed Shop Drawings, and material and equipment submittals. Copies of rejected submittals and Shop Drawings are not to be provided.
4. Operating instructions for heating and cooling and other mechanical systems. Operating instructions shall include recommended maintenance and seasonal change-over procedures.
5. Other data and drawings required during construction.
6. Repair parts lists of all major items and equipment including name, address, and telephone number of local supplier or agent.
7. Valve tag charts and diagrams specified elsewhere herein.
8. "As-Built" Record Drawings shall be provided in electronic format on a CD (provide two (2) copies) in a PDF or DWG format as determined by the Owner.
9. Provide copies of all City Inspection Certificates of Approval.
10. Provide Contractor's Certification Statement that all equipment furnished and all work performed is in compliance with all applicable codes referenced in these specifications, or those which are currently in effect.

B. Provide not less than one (1) day of operating instructions per building, during the adjustment and testing period, to the Owner's operating personnel in order to familiarize them with the proper care and operation of all equipment.

C. All of the above data should be submitted to the Architect for approval at such time as the Contractor asks for his last payment request, just prior to his final payment request. In no case will any portion of retainage be released until these documents are submitted and accepted.

D. Refer to related portions of Division 1 for Project Close-Out requirements, Operation and Maintenance Data, Warranties, and other related certificates.

1.10 SHOP DRAWINGS AND SUBMITTALS

A. Contractor shall submit to the Architect shop drawings, product submittals, and catalog data on all ductwork, equipment, and materials designated on the Drawings and specified herein. Electronic Pdf copies of each shall be submitted.

B. Each submittal will be reviewed for compliance with general requirements of design and arrangement only; it is not a contract document and acknowledgment of compliance does not relieve the Contractor from responsibilities for performance of the work in compliance with all provisions and requirements of the Contract Documents. Job measurements and the coordination of all dimensions for proper fit of all parts of the work and performance of all equipment supplied to meet specification requirements are, and remain, specific responsibilities of the Contractor.

C. Shop Drawings shall be furnished by the Contractor for the work involved after receiving approval on the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job, and failure on the part of the Contractor to comply shall render him liable to stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary detailed drawings. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary; and, should there be any charges in connection with this, they shall be borne by the Contractor.

D. Shop Drawings submitted shall not consist of manufacturers' catalogues or tear sheets therefrom that contain no indication of the exact item offered. Rather, the submission on individual items shall designate the exact item offered and accessories as specified.

E. Shop Drawings are not intended to cover detailed quantitative lists of heating specialties, valves, air distribution devices, fixtures, and similar items, as the Drawings and specifications illustrate those items; and it is the Contractor's responsibility to procure the proper quantities required to comply with the established requirements.

F. Shop Drawings prepared to illustrate how equipment, piping, equipment, etc., can be fitted into available spaces will be examined under the assumption that the Contractor has verified the conditions shown. Review by the Architect shall not relieve the Contractor of responsibility in the event the material cannot be installed as shown on those Shop Drawings.

G. Various material submissions of such items as shown valve assemblies, backflow preventers, and other related items or accessories shall be assembled in brochures or in other suitable package form and shall not be submitted in a multiplicity of loose sheets. Cover sheets for each item submitted shall have sufficient bare space to allow for shop drawing review stamps

H. Contractor shall process his submitted data to insure that it conforms to the requirements of the Drawings and specifications, and there are no omissions and/or duplications.

I. Shop Drawings and Submittals shall be accompanied by certification from the Contractor, and firm preparing such, that Shop Drawings have been checked for, and are in compliance with, the Contract Documents, NFPA, Owner's Insurance Carrier and local authority having jurisdiction.

J. All Submittals and Shop Drawings shall have been submitted for review by the Architect and Engineer within 90 days after Contract Award Date.

1.11 PENETRATIONS THROUGH FIRE-RATED ASSEMBLIES

A. Seal voids around ducts and pipes penetrating fire-rated assemblies and partitions using fire-stopping materials and methods in accordance with provisions in Section 07 84 00, Fire-Stopping.

1.12 DRAWINGS

A. Drawings show diagrammatically the locations of the various pipes, valves and equipment, and the method of connecting and controlling them. It is not intended to show every connection in detail and all fittings required for a complete system. The systems shall include, but are not limited to, the items shown on the drawings. Exact locations of these items shall be determined by reference to the general plans and measurements at the building, and in full cooperation with work specified in other Divisions of these specifications; and, in all cases, shall be subject to the approval of the Architect. The Architect reserves the right to make any reasonable change in the location of any of this work without additional cost to the Owner.

B. Should any changes be deemed necessary in items shown on the Contract Drawings, the shop drawings, descriptions, and the reason for the proposed changes shall be submitted to the Architect for approval.

C. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention prior to bids being submitted; otherwise, the Contractor shall be responsible for the cost of any and all changes and additions that may be necessary to accommodate the installation of any particular apparatus.

D. Lay out all work maintaining all lines, grades, and dimensions according to these Drawings with due consideration for the work of others. Verify all dimensions at the site prior to any fabrication or installation. Should any conflict develop or installation be found impractical, the Architect shall be notified before any installation or fabrication, and the existing conditions shall be investigated and proper changes effected without any additional cost.

E. Titles of Sections and Paragraphs in these specifications are introduced merely for convenience and are not to be construed as a correct or complete segregation or tabulation of the various units of materials and work. The Architect does not assume any responsibility, either direct or implied, for omissions or duplications by the Contractor due to real or alleged error in the arrangement of matter in the Contract Documents.

1.13 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Equipment supplied as portions of work specified under other Divisions of these specifications shall be furnished with proper roughing-in diagrams and shall be installed as a part of Division 21.

B. Furnish materials and labor required for the connection of this equipment.

C. Contractor shall ascertain that all equipment so specified is included as part of this work.

1.14 COOPERATION

A. Coordinate all work indicated in Division 21 with work specified in other Divisions to assure proper and adequate interface with other portions of the work.

B. Maintain contact and be familiar with the progress of the general construction and the timely installation of sleeves and inserts, etc., before concrete is placed. Install the required systems in their several stages, at the proper time to expedite the work and avoid unnecessary delays in the progress of other portions of the work.

C. Should any questions arise between work specified in Division 21 with respect to other portions of work specified in other Divisions of the Specifications, reference shall be made to the Architect for instructions.

1.15 MATERIALS AND EQUIPMENT

A. All materials and equipment purchased shall be new. No used or reconditioned equipment will be allowed unless specifically noted on the Drawings.

B. All material shall be manufactured in the United States and/or shall comply with the North America Free Trade Agreement, NAFTA.

C. Substitutions: Products of same functions, performance and design will only be considered if in full accordance with the requirements of Division 01, Product Requirements. The products of other manufacturers will be acceptable; only if, in the opinion of the Architect, the substitute material is of a quality as good or better than the material specified, and will serve with equal efficiency, maintainability, and dependability, the purpose for which the items specified were intended.

D. Listed Manufacturers:

1. Manufacturers listed in a product or system specification are those manufacturers considered capable of manufacturing products conforming to the specification requirements, and are listed therein to establish a standard.
2. The "listing" of a manufacturer does not imply "acceptance" or "approval" of any standard product of that manufacturer.
3. Products offered by listed manufacturers shall be equal to, or superior in all respects to, that specified by named products; and shall meet or exceed specification requirements.
4. The description of specific qualities takes precedence over the reference standards and the description of qualities and reference standards together take precedence over the named product of listed manufacturers.

E. Product Options:

1. Products specified only by Reference Standards or by Description only means that any product meeting those standards or descriptions, by any manufacturer, will be considered.
2. Products specified by naming several products or manufacturers means that only the manufacturers named will be considered.
3. Products specified by naming only one product and manufacturer means that no option exists unless a substitution is accepted. Submit a request for substitution for any product or manufacturer not specifically named.
4. Products specified by Description, Reference Standard, and naming several products or manufacturers means that any product and manufacturer named meeting those descriptions and standards will be considered. Submit a request for substitution for any product or manufacturer not specifically named.

F. Limitations or Substitutions:

1. During Bidding Period, Instructions to Bidders, in Division 1, will govern times for submitting requests for substitutions under requirements specified in this Section.
2. No later than ten (10) days prior to the bid date, Contractor shall notify the Architect in writing of any desired substitutions of products in place of those specified. These requests will be considered; and, if a favorable response is determined, this will be documented in the form of an Addenda.
3. Substitutions will not be considered when indicated or implied on Shop Drawings or product data submittals without separate formal request, when requested directly by subcontractor or supplier, or when acceptance will require substantial revision of Contract Documents.
4. Substitute products shall not be ordered or installed without written acceptance.

5. Only one request for substitution for each product will be considered. If substitution is not accepted, Contractor shall provide specified product.
6. Architect will determine acceptability of any and all substitutions.

G. It is fully the Contractor's responsibility to assemble and submit sufficient technical information to fully illustrate that the material or equipment proposed for substitution is equal or superior, as the Architect is under no obligation to perform the service for the Contractor. The proposal shall be accompanied by manufacturer's engineering data, specification sheet, and a sample, if practical or if requested or specified. In no event shall a proposal for substitution be cause for delay of work. This shall include a detailed comparison to each product specification paragraph.

H. Should a substitution be accepted under the above provisions, and should the substitution prove defective or otherwise unsatisfactory for the intended service, within the warranty period, the Contractor shall replace the substitution with the equipment or material specified, and on which the specifications required him to base his proposal.

I. No substitutions will be considered contingent upon pending certification and rating agency approvals. Such certifications and ratings shall be in effect at the time of bidding.

1.16 EQUIPMENT SIZES AND REQUIREMENTS

A. Space allocations in machinery and mechanical equipment spaces are based on equipment scheduled in each case. Should the Contractor request a substitution for equipment of another make that requires more space in any critical dimension, the Contractor shall submit, together with other submittal data on the equipment, prints of drawings indicating how the equipment may be installed, indicating room for servicing and revisions in piping or ducting and any other details necessary for the Architect to form a judgment as to the suitability of the substitute material, as to performance, suitability for the space and other variables.

B. Duties of certain equipment items, horsepower’s of driving motors and electrical characteristics are scheduled for equipment items of a particular make in each case. Should requests for a substitute material be accepted which has other requirements that would involve allied equipment or other portions of work, the Contractor shall be responsible for all modifications required at no change in contract price. As examples:

1. If an accepted fire pump has a brake horsepower requirement above the motor horsepower scheduled, the Contractor shall be responsible for providing a larger motor and heavier drive and any change in size of the protective device, conduit run and conductors serving that motor. The latter shall be extended through an individual branch protective device and branch circuit on through the panel, feeder, feeder protective device, etc.
2. If accepted, fire pump, etc., having greater pressure drops than those on which pumping heads were based, the Contractor shall be responsible for selecting proper pumps and drives and adjusting electrical service work accordingly.

C. Structural steel members are indicated to provide supports for certain specific sizes and weights of equipment. Should a substitution request involve other equipment, the spacing of the supports shall be varied to suite the equipment. Should the weight or size of a proposed substituted item of equipment require additional supporting steel members, the Contractor shall include documentation of the additional supports in the request for substitution and install them at no change in contract price if the substitution is accepted.

D. Various large apparatus to be installed may require that the apparatus be installed prior to the installation of portions of structural, walls, or door frames. Coordinate the installation of these items to insure that no demolition of general construction is necessary for equipment installation or that the apparatus does not have to be disassembled for installation.

1.17 STORAGE AND PROTECTION OF MATERIALS

A. Store and protect materials and equipment as specified in Division 01, Product Requirements.

B. Contractor shall provide storage space for protection and storage of his materials and assume complete responsibility for all losses due to any cause whatsoever. All storage shall be within the property lines of the building site, and as directed by the Architect. In no case, shall storage interfere with traffic conditions in any public or project thoroughfare.

C. All work and material shall be protected at all times. Contractor shall make good any damage caused, either directly or indirectly, by his workmen. He shall be responsible for safe handling of all mechanical equipment and shall replace, without charge, all items damaged prior to acceptance by the Owner.

D. On site storage shall not be inside the building during construction progress, but shall be in approved trailers or as specifically approved otherwise by the Architect. Storage inside the building shall only be allowed when so allowed by the Architect.

1.18 FOUNDATIONS

A. Provide equipment foundations associated with the work specified in Division 21.

B. All top corners and edges of all foundations shall be neatly chamfered at a one inch (1") high 45 degree angle.

C. Foundation bolts shall be placed in the forms when the concrete is poured. Allow one inch (1") below the equipment bases for alignment, leveling, and grouting with non-shrinking grout. Grouting shall be done after the equipment is leveled in place. After the grout has hardened, the foundation bolts shall be pulled up tight and the equipment shimmed, if necessary.

D. After removal of the forms, the surface of the foundation shall be rubbed until smooth.

E. Unless otherwise noted, foundations shall be four inches (4") thick for fire pumps and motors and other mechanical equipment, unless thicker foundations are required or recommended by the equipment manufacturer.

F. All concrete work shall conform to the requirements of Division 03, Cast-in-Place Concrete.

G. Provide housekeeping pads and foundations for every item of floor mounted equipment specified in Division 21 specifications. Pads shall extend a minimum of two inches (2") in each direction beyond the equipment size.

1.19 EXCAVATION AND BACKFILLING

A. Contractor shall do all necessary excavating and backfilling for the installation of his work. Trenches for underground conduits shall be excavated to required depths with bell holes provided as necessary to insure uniform bearing. Care shall be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where rock or hard objects are encountered, they shall be excavated to a grade six inches (6") below the lowermost part of the piping and refilled to grade as specified. After the piping has been installed and reviewed by Architect and local building authorities, trenches shall be backfilled to grade with approved materials, well tamped or puddled compactly in place. Where streets, sidewalks, etc., are disturbed, cut, or damaged by this work, the expense of repairing same in a manner approved by Architect shall be a part of this contract.

B. Contractor shall bear sole responsibility for design and execution of acceptable trenching and shoring procedures, in accordance with State of Texas Regulations. On trench excavations in excess of five feet (5') in depth, Contractor shall pay a qualified engineer to prepare detailed Drawings and specifications directing Contractor in the safe execution of trenching and shoring. It is understood that trench safety

systems constitute a means and method of construction for which the Architect, Engineer, and Owner are not responsible. Accordingly, such documents when prepared, shall be separately issued by Contractor's Consultant, independent of project contract Documents.

1.20 WIRING

A. Unless otherwise noted, all wiring for motors, starters, and equipment is specified in Division 26.

B. Wiring of temperature controls shall be performed in accordance with the requirements of Division 26 but shall be performed as outlined in other sections of these specifications.

C. All power for control circuits required for the Temperature Control System shall be provided and installed where indicated on the Division 26 Drawings, but shall otherwise be provided as indicated in other sections of these specifications.

D. Each supplier of equipment requiring control shall have wiring diagrams furnished with submittals. This shall be used to determine conduit layouts required to complete the electrical portions of the instrumentation and control systems.

E. All motors furnished as a portion of work specified in Division 21 shall be wired as specified in Division 26.

F. Except where combination starter-disconnects are specified elsewhere herein or in Division 26, all motors shall be provided with safety disconnect switches in accordance with the National Electrical Code as specified in Division 26.

G. Furnish all necessary wiring diagrams for equipment specified in Division 21, as a part of equipment submittals, for installation under other sections of these specifications.

1.21 EQUIPMENT STANDARDS

A. All basic materials and equipment shall be standard catalog products of a reputable manufacturer and shall essentially duplicate equipment which has been in satisfactory service for at least one (1) year.

B. First of a kind new technology devices will not be considered.

C. Accessory equipment that is required to make a complete and functioning system that is not of the same manufacturer furnishing the basic materials or equipment shall carry the guarantee of the basic material or equipment manufacturer and repair and replacement parts shall be available through normal trade channels locally.

1.22 CLEAN UP

A. Contractor shall be responsible for cleaning up after and during all work performed under this Division of the Specifications.

B. Contractor shall, on a daily basis, remove construction trash and debris accumulation to minimize the entrance of dust, dirt, and debris in piping, ductwork, and mechanical equipment.

C. At the completion of construction, just prior to Substantial Completion and sustained operation of equipment, thoroughly clean the inside of piping, ductwork, and equipment.

D. Refer to Division 1.

1.23 FINAL CONSTRUCTION REVIEW

A. Schedule: Upon completion of the work specified in Division 21, there shall be a final construction review of the completed mechanical systems installations. Prior to this walk-thru, all work specified in this

Division shall have been completed, tested, adjusted, and balanced in its final operating condition and the preliminary test report shall have been submitted to and approved by the Architect.

B. Personnel: A qualified person representing the Contractor must be present at this final construction review to demonstrate the system and prove the performance of the equipment.

C. Building mechanical systems shall have been in operation for a minimum of 15 days.

D. Exceptions to the aforementioned requirements will be considered on a case-by-case basis dependent on the size and type of project, as well as construction schedule limitations.

1.24 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these Specifications.

B. Provide copies of all applicable approved notices and inspection certifications from the various inspections conducted by the Local Code Enforcement Authorities.

1.25 GUARANTEE

A. The guarantee provision of this specification requires prompt replacement of all defective workmanship and materials occurring within one year of final job acceptance, Substantial Completion, or as defined by Extended Warranty Contracts. This includes all work required to remove and replace the defective item and to make all necessary adjustments to restore the entire installation to its original specified operating condition and finish at the time of acceptance.

B. The Contractor shall also guarantee that the performance of all equipment furnished and installed under this Division of the Specifications shall be at least equal to the performance as called for in the specifications and as stated in the equipment submittals. Should there be indication that the equipment and installation is not producing the intended conditions, the Contractor shall make further tests as the Owner's Representative may direct to demonstrate that the equipment installed meets the specifications and is delivering the capacity specified or called for on the Drawings.

C. If there is any indication that the equipment does not meet the specified quantities, the Contractor shall, at his expense, institute a program to demonstrate the adequacy of the installation. This program shall include all necessary testing and testing equipment. Should the Contractor not have the equipment or technical skill to perform the tests, it shall be his responsibility to employ recognized experts to perform the tests and shall provide certified laboratory tests, certified factory reports and work sheets, or other certified data to support results of any tests required.

END OF SECTION

SECTION 21 13 00

COMBINED WET FIRE SPRINKLER AND STANDPIPE SYSTEM

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with Division 21 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of fire protection systems which shall include the automatic wet pipe sprinkler system and interior Fire Department valves in cabinets as shown on the Drawings, in locations as required by the Local AHJ and as approved by the Local authorities having jurisdiction for the new or renovated building.

B. The Classification of Fire Department Valve/Standpipe System shall be as required by Local AHJ, Owner's Insurance Carrier and NFPA 14. Dry Roof Fire Department Connection shall be provided where required by Local AHJ.

C. The extent of Fire Sprinkler piping work is not indicated by drawings and schedules. The successful Sub-Contractor shall prepare and submit drawings and schedules for approval by the requirements of this section and is hereby defined to include (but is not necessarily limited to) purchase and complete installation of alarm check valves and trim, feed and cross main piping, branch line piping, test valves, test conditions and sprinklers, stainless steel backflow preventer assembly (type as required by Local AHJ) and inside Fire Department valve connections as required by local authorities. Fire Sprinklers, interior fire department valves and standpipes in stairwells shall be installed to serve the entire Building Complex.

D. A sprinkler/standpipe layout is not shown on the plans. The successful Sub-Contractor shall prepare shop drawings for the hydraulically designed sprinkler system and secure approval of same from the Owner's Insurance Carrier, I.S.O. Commercial Risk Services Group representing the Texas State Insurance Authorities Review Board, and Local City Authorities. Approved plans and submittals shall be submitted to the Owner's Representative for approval before any materials are fabricated.

E. The Sprinkler Systems shall be served by two (2) sprinkler valve and reworking of existing sprinklers assemblies. The system shall be limited to a maximum of 52,000 square feet per floor in accordance with NFPA-13 and 14, and International Fire Code. The Sub-Contractor shall extend the sprinkler system piping to the property line or as shown on the drawings. Sub-Contractor shall coordinate with others to provide the City water tap.

F. The Fire Department hose valves and standpipes shall meet the requirements of NFPA 14 as indicated and where required by the local Fire Department. The Fire Department valves shall be located in fire department hose valve cabinets and located in the stairwells. Cabinets shall be as specified herein and located per Architectural drawing. Provide fire department valve/standpipe classification as required by the local AHJ. The piping system shall be hydraulically calculated to include 500 gpm at 100 psig for a Class I standpipe system at the most remote Fire Department valve location. Piping system shall be designed to withstand the maximum booster water pressure and flowrate from the local fire department pumpers.

G. The Contractor shall obtain from the City a current water flow test close as possible to the proposed building addition use this information for the basis of design of the hydraulically calculated system. Flow test shall have been taken in the last six months. Should a current flow test not be available, the Contractor shall conduct the test in the presence of the local fire department representative. This information shall be used in conjunction with the fire pump curve] for the basis of design of the hydraulically calculated system. If the city static water pressure plus the pump head at churn minus the elevation head loss exceeds 175 psi on the system, high pressure pipe shall be used for mains and standpipe risers and pressure regulating devices shall be used for cross mains and branch lines on the floors to limit pressures to 175 psi or less in both the static and dynamic conditions. Pressure regulating devices for the standpipe hose outlets shall be set to limit the maximum outlet pressure at all flow conditions from 0-250 gpm to 125 psi. Pressure regulating devices shall be factory set and labeled for the specific location in the building.

H. The Contractor shall comply with NFPA 13, “Water Supply Treatment” in areas with water supplies known to have contributed to Microbiologically Influenced Corrosion (MIC) of sprinkler piping. The Contractor shall provide an Alternate Bid for testing and appropriately treating the water supply.

I. The Contractor shall obtain, from the City, a water flow test as close as possible to the proposed building site. The test shall have been taken within the last six months and this information shall be used for the basis of design of the hydraulically calculated system.

J. The sprinkler system shall designated to meet the hydraulically most remote requirements. Provide GPM density and remote area square footage as required by Owner’s Insurance Carrier and by NFPA Standards. (The most stringent shall be used).

K. In addition to the requirements of the governing authorities, the following design criteria shall be met:

1. A 10 psig safety factor shall be designed into all the hydraulic calculations.
2. The maximum velocity in the pipes shall not exceed 32 ft./sec.
3. Head spacing shall not exceed 400 sq. ft. for light hazard areas and 130 sq. ft. for ordinary hazard areas such as mechanical rooms. Head spacing shall be further restricted by ceiling type where appropriate per NFPA-13. Extended coverage heads may be used only where noted.
4. A main drain shall be provided next to the main sprinkler/standpipe riser.
5. Floor openings shall be projected by closely spaced sprinkler heads in combination with draft stops as required by NFPA 13.

1.3 QUALITY ASSURANCE

A. The manufacturer shall be a firm regularly engaged in the manufacture of fire protection equipment and accessories of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. The installer shall be a firm with at least two (2) years of successful installation experience on projects with fire protection equipment and piping similar to that required for this project.

C. The Contractor shall be licensed by the Texas Commission on Fire Protection for sprinkler installation and shall have five (5) years experience installing sprinkler systems of this size and scope. The contractor shall provide evidence of these requirements upon request. The contractor shall have an established service organization within a 50 mile radius of the job site.

D. FM Compliance: Comply with Factory Mutual “Approval Guide”.

1. FM approvals Marks: Provide units bearing FM approval marks.

E. UL Labels: Provide units which have been approved and listed by Underwriter’s Laboratories.

F. Comply with NFPA Standards, Governing Fire Prevention Code, Local Regulations and Ordinances governing fire sprinkler piping.

G. Coordinate with fire alarm installation for required monitoring of the sprinkler system.

H. All material shall be manufactured in the United States and/or shall comply with the North America Free Trade Agreement, NAFTA.

1.4 GOVERNING AUTHORITIES

A. Each combined standpipe and automatic sprinkler system shall comply with applicable State and City codes, with the requirements of other authorities having jurisdiction, and with the requirements of NFPA-13 and NFPA-14.

B. Comply with all requirements of the Owner's Insurance Carrier, and the City Authorities. Provide sprinkler products bearing approval from Underwriter's Laboratories.

1.5 SUBMITTALS

A. Submit coordinated shop drawings and details of each fire protection system to, and receive approval from, the governing authorities before the submittal is forwarded to the Owner's Representative, and before installation work is started. Refer to Section 21 05 00 and appropriate Architectural section.

B. Submit to the Owner's Representative, upon completion of each system, a certificate stating that the work has been completed and tested in accordance with NFPA-13, that there are no defects in the system, and that it is operational. Test procedures and certificate format shall be in accordance with NFPA-13 and NFPA 14 unless otherwise directed by the governing authorities.

C. Submit to the Owner's Representative upon completion of the system, manufacturer data of all products incorporated in this work.

D. Submit the following Products Data, Shop Drawings and Samples:

	Product Data	Shop Drawings	Samples
Heads	X	X	
Valves	X	X	
Hangers	X	X	
Jointing Method	X		

1.6 MAINTENANCE STOCK, FIRE SPRINKLERS

A. Maintenance Stock: For each style and temperature range required, furnish an additional two (2) fire sprinklers, cover plates and escutcheons, for every 100 units installed, but not less than six (6) units of each type and twelve (12) concealed sprinkler covers of each type.

1.7 COORDINATION

A. The Sub-Contractor shall examine all other work shown on the plans and such work installed at the job site. The sprinkler system Sub-Contractor shall coordinate the routing of his work with the other construction trades to avoid interference with the other installations. Pipe routing shall be located as required to avoid equipment, plumbing drain pipe, heating and air conditioning piping, ductwork, light fixtures, and electrical buss ducts. This Sub-Contractor shall provide pipe offsets, etc., as required to complete the installation. Shop prefabricated piping, pipe hangers, etc., shall be modified as required to fit the job site conditions.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Cover and protect materials in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall be rejected.

B. Storage and protection of materials shall be in accordance with Section 21 00 00.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall comply with the requirements of NFPA-13 and 14, Owner's insurance carrier/ I.S.O. Commercial Risk Services Group, U.L., FM, and Section 21 05 00.

2.2 PIPE AND FITTINGS

A. Underground within 5'-0" of the Building:

1. Type: AWWA C151, Class 52 cement lined, ductile iron.
2. Wrapping: Buried pipe wrapped with 8 mil polyethylene encasement, AWWA C105.
3. Buried Fittings (size 4 inch through 12 inch): Ductile iron compact type with push-on joints, ANSI A21.53/AWWA C153, or standard fittings, AWWA C110. Use mechanical joints with retainer glands where required for complete system. Equal to Tyco or Victaulic.
4. Underground riser, welded 304 stainless steel one-piece riser assembly with flanged end and tie-rod bracket, UL and FM approved, AMES Model "1 BR Series".

B. Underground 5'-0" beyond the Building: Pressure Class 200, polyvinyl chloride (PVC) water pipe conforming to ASTM D-2241, AWWA C-900 DR 14 with cast iron pipe outside dimension requirements of size indicated. Fittings shall be minimum Class 300 ductile iron conforming to ANSI A21-10.

1. Contractor shall refer to 22 05 53 for underground trace wire requirements.

C. Above Grade, Indoor Piping: Pipe Size 1-1/2 Inch and Smaller ASTM A-53/135, Schedule 40, black steel pipe, piping by Bull Moose, Allied, or Wheatland Tube. Provide fittings as follows:

1. Fittings: Pipe Size 1-1/2 Inch and Smaller: Class 300 malleable iron, threaded fittings, ANSI B16.3.
2. Acceptable manufacturers: Victaulic, Tyco, or Anvil.

D. Above Grade, Indoor Piping: Pipe Size 2 Inch and Larger ASTM A-53/135, Schedule 10, black steel pipe, piping by Bull Moose, Allied, or Wheatland Tube. Provide fittings as follows:

1. Fittings: Pipe Size 2 Inch and Larger: UL listed, FM approved mechanical grooved couplings with flush sealed gasket style equal to Victaulic Style 75 Flexible Couplings, minimum 500 psig rating.
2. Acceptable manufacturers: Victaulic, Tyco, or Anvil.

E. No Mechanical Tees shall be installed.

F. Outdoors or Exposed to Moisture: Same as specified for "Above Grade, Indoor Piping", except pipe shall be hot dipped galvanized.

G. Fire Sprinkler Drain Piping:

1. Pipe size 2" and smaller: Black steel pipe and fittings: Pipe weight: Schedule 40; Fittings: Class 125 cast iron screwed; Fittings: Class 150 malleable iron, screwed.
2. Pipe size 2-1/2" and larger: Black steel pipe and fittings: Pipe weight: Schedule 40; Fittings: Wrought iron or Schedule 10, rolled-grooved couplings and fittings.

2.3 PIPE SLEEVES

A. Pipe sleeves through grade beams or ground floor slab shall receive “Link Seal” closures made of interlocking synthetic rubber links. Seals shall provide for absolute water tightness. Seal shall be constructed to insulate electrically pipe from wall. Install as recommended by manufacturer. Provide Century-Line sleeves with water stop and anchor collar for pipes penetrating grade beams designated to be anchored.

2.4 VALVES

A. General: Conform to the requirements of NFPA-13 and NFPA-14.

B. Check Valves: Provide Victaulic “FireLok” 717 Series, or Tyco CV-1F, check valves 2-1/2" and larger with automatic ball drips for fire department connections.

C. Alarm Valve Assemblies: Provide approved alarm valves, 175 LBS rated pressure complete with all variable pressure trim, valves, etc., as required, equal to Tyco CV-1FR.

D. Sectional Valves: Provide indicating butterfly control valve, BFV-N, 175 LB rated working pressure, of size and end types indicated: 2-1/2" and larger: Tyco or Victaulic “FireLok” 705 Series.

E. Floor Control Valve Assembly: Provide a floor control valve assembly where a single sprinkler alarm valve assembly controls more than one floor level. Unit shall be monitored by a flow switch. Drain line from control valve shall be routed to the exterior portion of the building wherever possible and terminated open sight a minimum of 6” above the finished grade. Victaulic “Firelock” Series control valve assembly. Equal by Tyco or Viking.

2.5 AUTOMATIC SPRINKLERS

A. Fire Sprinklers: Provide standard coverage quick-response Bulb-Type, (“O-Ring” water seal design not acceptable) automatic fire sprinklers with 165 Deg.F. or as required by NFPA-13, operating temperature of the following style and finish (all sprinkler heads shall be centered in the ceiling tiles). Acceptable manufacturer’s: Tyco, Reliable or Viking.

B. NOTE: Sprinklers shall be limited to 400 sq. ft. coverage for light hazard and 130 sq. ft. for ordinary hazard area. Extended coverage sprinklers are not allowed.

1. Upright type in mechanical spaces without ceilings equal to Tyco TY-FRB. Sprinkler Finish: Cast brass (in non-exposed areas) and chrome plated (in occupied areas).
2. Provide fully concealed pendent type in all finished areas with ceiling or soffitt with factory painted "off-white" threaded cover plate equal to Tyco Quick Response concealed sprinkler model RFII “Royal Flush II”.
3. Provide in heated spaces only exposed chrome plated horizontal and vertical side wall sprinklers equal to Tyco-TY-FRB.
4. Provide in heated spaces only, recessed chrome plated horizontal sidewall sprinklers equal to TYCO series EC.

C. Emergency Head Storage Cabinet: Provide a red, baked enamel, steel sprinkler cabinet to store the extra sprinklers and wrenches, as required by NFPA-13.

D. Provide cage guards for sprinkler head where sprinklers are installed at or below 8'-0". Cage guards shall be UL listed and engineered products equal to SprinkGuard products.

2.6 ACCESSORIES

A. Tamper Switches: Provide tamper switches equal to Potter Type OSYSU or PCVS Series on all control valves for connection to the fire alarm system.

B. Water Flow Detectors: Provide a water flow detector equal to Potter Type VSR Series at the main fire protection piping entrance to the building or system, in addition to other locations shown, specified, or required, to detect any flow in the system from any cause. If flow is detected, sound a local alarm. See fire alarm section for connection to fire alarm system.

C. Pressure Gauges: Provide 3-1/3 inch diameter, Potter-Roemer No. 6240 pressure gauges with stainless steel case and with a range of 0-300 psig, include gauge cock.

D. Wall Mounted Weather-Proof Horn/Strobe: Provide wall mounted weatherproof, red finished, 120V exterior horn/strobe UL listed FM approval with back box equal to Potter SH-120 Series.

E. Ball Drips: Provide Tyco AD-2, automatic ball drips for piping between check valves and fire department connections. Extend drain line from each ball drip to point of disposal as shown on the Drawings, or as directed.

F. Hangers and Supports: Provide hangers and supports as required by NFPA-13.

G. Flexible Sprinkler Drops shall only be allowed if they are hydraulically designed in the system calculations. Flex connections shall not exceed 36” in length. Flexible drops shall be braided stainless steel as manufactured by Flex Head or Victaulic VicFlex.

H. Automatic Air Vents: Provide as required by NFPA 13, shall be UL listed, FM approved rated up to 175 psig. Provide with ball valve and union upstream of the y-strainer. Potter PAV or pre-approved equal.

I. Floor Control Valve Assemblies: Where two or more stories are present provide with a floor control riser manifold assembly. Provide where indicated on the drawings. Shall be UL Listed and FM approved, provided with a pressure gauge, waterflow alarm switch, ball valve, and integral test drain and/or pressure relief valve (as required to meet NFPA 13). Viking EasyPAC or equal by Reliable or Tyco.

J. Outside Fire Department Connections:

1. Free standing type device shall be Potter-Roemer No. 5760, 2-way, Fire Department Connection with individual drop clapper valves, plugs, chain, and escutcheon lettered “AUTO.SPKR”. Entire unit shall have polished chrome finish, size shall be 2-1/2" x 2-1/2" x 4" with Knox Cap. Provide “Storz” connection as required by local Fire Department equal by Guardian Fire Equipment or Croker.

K. Post Indicating Valve: Provide Watts 757 series vertical indicating valve for isolation of the roof fire department connection or equal by Tyco or Mueller. Provide where required by Local Authorities. Provide extra contacts and coordinate with Fire Alarm Contractor to monitor valve position through the Building Fire Alarm System.

2.7 PROTECTION OF ELECTRICAL EQUIPMENT

A. Where required, provide metal hoods or shields to protect electrical equipment and bus ducts from sprinkler discharge.

B. No sprinkler mains or branches shall pass through an Electrical Room, IDF Room or MDF Room.

C. Only the branch line serving that specific Electrical Room, IDF Room or MDF Room shall enter that specific room.

2.8 FIRE DEPARTMENT VALVE AND CABINET

A. Provide 20 gauge fully-recessed solid metal steel box and solid metal door, 20 gauge flush solid aluminum door with 18 gauge frame with continuous steel hinge (Brass pin). Steel corner seams

welded and ground smooth. Door and frame finished shall be determined by the Architect. Coordinate with Architect for finish. Cabinet shall be equal to Potter-Roemer #1810-AL-F.

B. Valve in Cabinet: Potter-Roemer 4500 Series 1700 U.L. rough brass 175 psig fire line angle valve with malleable iron handles, 2-1/2" x 2-1/2" with 1-1/2" reducer, Potter-Roemer 4600 Series 120 rough brass pin lug with threads suitable for connection of local fire department hoses.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install combined standpipe and automatic sprinkler system where shown on the Drawings or as noted. Installation shall comply with the requirements of NFPA-13 and NFPA-14, Local Fire Code, these Specifications, and the governing authorities, and with the manufacturers' written instructions. Coordinate with other work, including plumbing piping, as necessary to interface components of fire sprinkler piping properly with other work.

B. Welding shall comply with the requirements of Section 21 05 00 and State Insurance Authorities, and NFPA 51B. No butt welds are allowed.

C. Provide pipe offsets as required. Modify shop pre-fabricated piping, pipe hangers, and other components as required to fit the job site conditions.

D. Installation of hoods and shields for protection of electrical equipment shall be in accordance with approved details, included as a part of the coordinated shop drawings.

E. Install sectional valves in inlet piping at the bottom of each riser and in loops as indicated or required.

F. Install air vents at the high points of the sprinkler piping.

G. Install a tamper switch on hose connection cabinet door, each sectional valve and on each other shut-off valve.

H. Install drain piping at all low points of the sprinkler piping.

I. Thrust blocks shall be of size required for the soil bearing strength and against compacted soil.

J. Install water flow detectors at each take-off from a sprinkler riser or for each zone.

K. Install pressure reducing valves as required by NFPA 13.

L. Install heads in all locations, pendant or upright, as required to provide complete coverage. Sprinkler shall be strictly coordinated with diffusers, grills, lights, ceiling type, and other trades.

M. Install sprinklers in finished ceilings to be centered on ceiling pattern; center of 2 x 2, or 2 x 4, tiles; centered both ways for special pattern ceilings. Coordinate head locations with ceiling finishes and types. Provide additional sprinklers as necessary for symmetrical layout. Refer to Architectural Reflected Ceiling Plan for ceiling type and suggested head location. Where head locations are not shown, locate as required and submit to Architect for approval prior to installation.

N. No mechanical tees shall be installed.

3.2 IDENTIFICATION

A. Apply signs to identify purposes and functions of controls, and to identify drain, test, and alarm valves. Provide letter sizes and styles as selected by the Owner's Representative from NFPA's suggested styles.

3.3 CLEANING AND FLUSHING

A. Prior to connecting sprinkler piping for flushing, flush water feed mains, lead-in connections and control portions of sprinkler piping. After sprinkler piping installation has been completed, and before piping is placed in service, flush each sprinkler system under pressure to remove foreign substances as required by NFPA-13 and NFPA-14. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

3.4 TESTS

A. After flushing each system, hydrostatically test sprinkler piping in accordance with NFPA-13 and NFPA-14. Check system for leakage at joints. Measure hydrostatic pressure at low point of each system or zone being tested.

B. Repair or replace piping system as required to eliminate leakage in accordance with NFPA Standards, then retest as specified to demonstrate compliance.

3.5 CERTIFICATION

A. Before final approval of the fire protection systems are requested, provide the Owner's Representative a statement that all requirements of the State Board of Insurance, City Building Inspection, Owner’s Insurance and Fire Departments have been met in the installation of the fire protection systems.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Conditions of the Contract including the General Conditions, Supplementary Conditions, and Division One, apply to all work of this Division, whether attached or not.

B. The requirements specified in this Section shall be applicable to work specified in other Sections within this Division.

1.2 SCOPE OF WORK

A. All Division 22 sections of these specifications shall include all labor and material to complete the entire mechanical systems as specified and shown on the Drawings.

B. All work shown and specified shall be completely installed and connected by mechanics properly qualified to perform the work required. All work shall be left in a satisfactory operating condition as determined by the Owner and Owner's Representative.

C. Provide all services and perform all operations required in connection with, or properly incidental to, the construction of complete and fully operating systems with all accessories as herein specified and shown on the Drawings.

D. Refer to "Conditions of Work" in Division 1

1.3 GENERAL

A. The accompanying Drawings show diagrammatically the sizes and location of the various equipment items and the sizes of the major interconnecting piping and without showing exact details as to elevations, offsets, control lines, and other installation details. The Contractor shall carefully lay out his work to conform to the site conditions, to avoid obstructions and provide proper grading of lines. Exact locations of outlets, apparatus, and connections thereto shall be determined by reference to the Drawings, reviewed Shop Drawings, including equipment drawings, and rough-in drawings, by measurements at the building, and in cooperation with work specified in other sections of these specifications. Minor relocations necessitated by the conditions at the site or directed by the Architect shall be made without any additional cost to the Owner.

B. These specifications and the accompanying Drawings are intended to describe and illustrate systems which will not interfere with the structures, which will fit into available spaces, and which will insure complete and satisfactorily operating installations. Contractor shall coordinate the proper fitting of all material and apparatus into the building and shall prepare larger scale installation drawings for all critical areas, areas with limited working clearances, and areas of significant congestion requiring a higher level of coordination illustrating the installation of work specified in Division 22 in relation to all other portions of work specified in other Sections of these Specifications. Interferences with other portions of work, or the building structure, shall be corrected before any work proceeds. Should changes become necessary on account of the failure of the Contractor to comply with these stipulations, Contractor shall make all necessary changes at no expense to the Owner.

C. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted on the Drawings.

D. It is the intent of the Contract Documents to provide an installation complete and operational in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section, or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems and required to complete the installation.

E. Contractor sets forth that all personnel have the necessary technical training and ability; and that all work specified in this Division will be installed to the best standard of each trade, and will be complete and in good working order. If any of the requirements of the Drawings and specifications are impossible to perform, or if the installation when made in accordance with such requirements will not perform satisfactorily, report same to the Architect promptly after discovery of the discrepancy.

F. No extra compensation will be allowed for extra work or changes caused by failure to comply with the above requirements.

1.4 EXAMINATION OF THE SITE

A. Contractor shall visit the site, verify all items indicated on the Drawings or specified, and familiarize himself with the work conditions, hazards, grades, actual formations, soil conditions, points of connection, utility locations, and local requirements.

B. Contractor shall take these conditions into consideration, and the lack of specific information on the Drawings shall not relieve the Contractor of any responsibility.

C. All site visits shall be coordinated and scheduled with the Owner.

1.5 CUTTING AND PATCHING

A. Excessive cutting of the building structure, walls, floors, ceilings, roof, etc., will not be permitted. No structural member shall be notched or cut unless specifically shown on the Drawings, or unless such cutting is authorized by the Architect.

B. Provide for all holes or openings of proper size and shape as may be necessary for the proper installation of work specified in Division 22, consulting with the Architect regarding proper locations and sizes.

C. Where deemed necessary, and after consulting with the Architect, perform all cutting and patching required for the installation of piping, etc. This shall include the cutting of concrete floors, concrete and tile floors, walls, ceilings, roofs, etc. It shall also include patching them as required to restore work to match existing finishes, following installation, testing, backfilling, insulation, etc.

D. Holes through concrete shall be drilled with "Mole", "Core-It', or other diamond point hole saw.

E. Refer to Division 01, Cutting and Patching.

1.6 CODE REQUIREMENTS

A. Contractor is required to comply with the requirements of all National, State, and local codes and utility companies having jurisdiction. In no case does this relieve the Contractor of the responsibility of complying with the requirements of these specifications and Drawings where specified conditions are of higher quality than the requirements of the above specified offices. Where requirements of the specifications and Drawings are below the requirements of the above offices having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above offices and shall notify the Architect promptly.

B. Contractor shall comply with the requirements and standards set forth by, but not limited to, the following:

1. (NFPA) National Fire Protection Association.
2. (OSHA) Occupational Safety and Health Administration.

3. (NEC) National Electric Code.
4. (IECC) International Energy Conservation Code.
5. Local Plumbing Code.
6. Local Building Code.
7. Local Fire Code.
8. Local Energy Code.

C. Contractor shall obtain all permits, inspections, and approvals as required by all authorities having jurisdiction. Fees and costs incidental to these permits, inspections, and approvals must be assumed and paid by the Contractor.

1.7 RECORD DRAWINGS

A. Contractor shall, during the execution of work, maintain a complete set of “Record Drawings” upon which all locations of equipment, ductwork, piping, and all deviations and changes in the work shall be neatly recorded for use in producing "As Builts" at Project Close- Out. This shall include the incorporation of all Supplemental Drawings issued during the Construction Period.

B. All “Record Drawings” shall be reviewed monthly during the Construction Period, along with the monthly Pay Application Request.

C. Refer to Division 01, Execution and Close-Out Requirements.

1.8 RECORDS AND INSTRUCTIONS FOR OWNER

A. Accumulate during the job's progress the following sets, in triplicate, in accordance with the provisions of Division 01, Execution and Close-Out Requirements:

1. Warranties and guarantees and manufacturer's directions on equipment and material covered by the Contractor.
2. Equipment and fixture brochures, wiring diagrams, and control diagrams.
3. Copies of reviewed Shop Drawings, and material and equipment submittals. Copies of rejected submittals and Shop Drawings are not to be provided.
4. Operating instructions for heating and other plumbing systems. Operating instructions shall include recommended maintenance and seasonal change-over procedures.
5. Other data and drawings required during construction.
6. Repair parts lists of all major items and equipment including name, address, and telephone number of local supplier or agent.
7. Valve tag charts and diagrams specified elsewhere herein.
8. "As-Built" Record Drawings shall be provided in electronic format on a CD (provide two (2) copies) in a PDF or DWG format as determined by the Owner.
9. Provide copies of all City Inspection Certificates of Approval.
10. Provide Contractor's Certification Statement that all equipment furnished and all work performed is in compliance with all applicable codes referenced in these specifications, or those which are currently in effect.

B. Provide not less than one (1) day of operating instructions per building, during the adjustment and testing period, to the Owner's operating personnel in order to familiarize them with the proper care and operation of all equipment.

C. All of the above data should be submitted to the Architect for approval at such time as the Contractor asks for his last payment request, just prior to his final payment request. In no case will any portion of retainage be released until these documents are submitted and accepted.

D. Refer to related portions of Division 1 for Project Close-Out requirements, Operation and Maintenance Data, Warranties, and other related certificates.

1.9 SHOP DRAWINGS AND SUBMITTALS

A. Contractor shall submit to the Architect shop drawings, product submittals, and catalog data on all piping, equipment, and materials designated on the Drawings and specified herein. Electronic Pdf copies of each shall be submitted.

B. Contractor shall submit full product data shop drawings and shall prepare and submit 1/4" = 1'-0" scale plumbing piping shop drawings. Contractor shall fully coordinate all piping shop drawings with sheet metal shop drawings and other trades. Failure to submit shop drawings in a timely manner, as required to keep pace with the construction and work of all other trades, will result in delays, and possible stoppage, of payment to the contractor. Additionally, no work may proceed until such shop drawings are submitted, reviewed, and found to be acceptable by the engineer.

C. Each submittal will be reviewed for compliance with general requirements of design and arrangement only; it is not a contract document and acknowledgment of compliance does not relieve the Contractor from responsibilities for performance of the work in compliance with all provisions and requirements of the Contract Documents. Job measurements and the coordination of all dimensions for proper fit of all parts of the work and performance of all equipment supplied to meet specification requirements are, and remain, specific responsibilities of the Contractor.

D. Shop Drawings shall be furnished by the Contractor for the work involved after receiving approval on the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job, and failure on the part of the Contractor to comply shall render him liable to stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary detailed drawings. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary; and, should there be any charges in connection with this, they shall be borne by the Contractor.

E. Shop Drawings submitted shall not consist of manufacturers' catalogues or tear sheets therefrom that contain no indication of the exact item offered. Rather, the submission on individual items shall designate the exact item offered and accessories as specified.

F. Shop Drawings are not intended to cover detailed quantitative lists of valves, devices, fixtures, and similar items, as the Drawings and specifications illustrate those items; and it is the Contractor's responsibility to procure the proper quantities required to comply with the established requirements.

G. Shop Drawings prepared to illustrate how equipment, piping, etc., can be fitted into available spaces will be examined under the assumption that the Contractor has verified the conditions shown. Review by the Architect shall not relieve the Contractor of responsibility in the event the material cannot be installed as shown on those Shop Drawings.

H. Various material submissions of such items as plumbing fixtures, drains, and other related items or accessories shall be assembled in brochures or in other suitable package form and shall not be submitted in a multiplicity of loose sheets. Cover sheets for each item submitted shall have sufficient bare space to allow for shop drawing review stamps.

I. Contractor shall process his submitted data to insure that it conforms to the requirements of the Drawings and specifications, and there are no omissions and/or duplications.

J. Shop Drawings and Submittals shall be accompanied by certification from the Contractor, and firm preparing such, that Shop Drawings have been checked for, and are in compliance with, the Contract Documents.

K. All Submittals and Shop Drawings shall have been submitted for review by the Architect and Engineer within 90 days after Contract Award Date.

1.10 PENETRATIONS THROUGH FIRE-RATED ASSEMBLIES

A. Seal voids around pipes penetrating fire-rated assemblies and partitions using fire-stopping materials and methods in accordance with provisions in Section 07 84 00, Fire-Stopping.

1.11 DRAWINGS

A. Drawings show diagrammatically the locations of the various pipes, fixtures, and equipment, and the method of connecting and controlling them. It is not intended to show every connection in detail and all fittings required for a complete system. The systems shall include, but are not limited to, the items shown on the drawings. Exact locations of these items shall be determined by reference to the general plans and measurements at the building, and in full cooperation with work specified in other Divisions of these specifications; and, in all cases, shall be subject to the approval of the Architect. The Architect reserves the right to make any reasonable change in the location of any of this work without additional cost to the Owner.

B. Should any changes be deemed necessary in items shown on the Contract Drawings, the shop drawings, descriptions, and the reason for the proposed changes shall be submitted to the Architect for approval.

C. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention prior to bids being submitted; otherwise, the Contractor shall be responsible for the cost of any and all changes and additions that may be necessary to accommodate the installation of any particular apparatus.

D. Lay out all work maintaining all lines, grades, and dimensions according to these Drawings with due consideration for the work of others. Verify all dimensions at the site prior to any fabrication or installation. Should any conflict develop or installation be found impractical, the Architect shall be notified before any installation or fabrication, and the existing conditions shall be investigated and proper changes effected without any additional cost.

E. Titles of Sections and Paragraphs in these specifications are introduced merely for convenience and are not to be construed as a correct or complete segregation or tabulation of the various units of materials and work. The Architect does not assume any responsibility, either direct or implied, for omissions or duplications by the Contractor due to real or alleged error in the arrangement of matter in the Contract Documents.

1.12 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Equipment supplied as portions of work specified under other Divisions of these specifications shall be furnished with proper roughing-in diagrams and shall be installed as a part of Division 22.

B. Furnish materials and labor required for the connection of this equipment.

C. Contractor shall ascertain that all equipment so specified is included as part of this work.

1.13 COOPERATION

A. Coordinate all work indicated in Division 22 with work specified in other Divisions to assure proper and adequate interface with other portions of the work.

B. Maintain contact and be familiar with the progress of the general construction and the timely installation of sleeves and inserts, etc., before concrete is placed. Install the required systems in their several stages, at the proper time to expedite the work and avoid unnecessary delays in the progress of other portions of the work.

C. Should any questions arise between work specified in Division 22 with respect to other portions of work specified in other Divisions of the Specifications, reference shall be made to the Architect for instructions.

1.14 MATERIALS AND EQUIPMENT

A. All materials and equipment purchased shall be new. No used or reconditioned equipment will be allowed.

B. All material shall be manufactured in the United States and/or shall comply with the North America Free Trade Agreement, NAFTA.

C. Substitutions: Products of same functions, performance and design will only be considered if in full accordance with the requirements of Section 01 60 00, Product Requirements. The products of other manufacturers will be acceptable; only if, in the opinion of the Architect, the substitute material is of a quality as good or better than the material specified, and will serve with equal efficiency, maintainability, and dependability, the purpose for which the items specified were intended.

D. Listed Manufacturers:

1. Manufacturers listed in a product or system specification are those manufacturers considered capable of manufacturing products conforming to the specification requirements, and are listed therein to establish a standard.
2. The "listing" of a manufacturer does not imply "acceptance" or "approval" of any standard product of that manufacturer.
3. Products offered by listed manufacturers shall be equal to, or superior in all respects to, that specified by named products; and shall meet or exceed specification requirements.
4. The description of specific qualities takes precedence over the reference standards and the description of qualities and reference standards together take precedence over the named product of listed manufacturers.

E. Product Options:

1. Products specified only by Reference Standards or by Description only means that any product meeting those standards or descriptions, by any manufacturer, will be considered.
2. Products specified by naming several products or manufacturers means that only the manufacturers named will be considered.
3. Products specified by naming only one product and manufacturer means that no option exists unless a substitution is accepted. Submit a request for substitution for any product or manufacturer not specifically named.
4. Products specified by Description, Reference Standard, and naming several products or manufacturers means that any product and manufacturer named meeting those descriptions and standards will be considered. Submit a request for substitution for any product or manufacturer not specifically named.

F. Limitations or Substitutions:

1. During Bidding Period, Instructions to Bidders, in Division 1, will govern times for submitting requests for substitutions under requirements specified in this Section.
2. No later than ten (10) days prior to the bid date, Contractor shall notify the Architect in writing of any desired substitutions of products in place of those specified. These requests will be considered; and, if a favorable response is determined, this will be documented in the form of an Addenda.
3. Substitutions will not be considered when indicated or implied on Shop Drawings or product data submittals without separate formal request, when requested directly by subcontractor or supplier, or when acceptance will require substantial revision of Contract Documents.
4. Substitute products shall not be ordered or installed without written acceptance.
5. Only one request for substitution for each product will be considered. If substitution is not accepted, Contractor shall provide specified product.
6. Architect will determine acceptability of any and all substitutions.

G. It is fully the Contractor's responsibility to assemble and submit sufficient technical information to fully illustrate that the material or equipment proposed for substitution is equal or superior, as the Architect is under no obligation to perform the service for the Contractor. The proposal shall be accompanied by manufacturer's engineering data, specification sheet, and a sample, if practical or if requested or specified. In no event shall a proposal for substitution be cause for delay of work. This shall include a detailed comparison to each product specification paragraph.

H. Should a substitution be accepted under the above provisions, and should the substitution prove defective or otherwise unsatisfactory for the intended service, within the warranty period, the Contractor shall replace the substitution with the equipment or material specified, and on which the specifications required him to base his proposal.

I. No substitutions will be considered contingent upon pending certification and rating agency approvals. Such certifications and ratings shall be in effect at the time of bidding.

1.15 EQUIPMENT SIZES AND REQUIREMENTS

A. Space allocations in machinery and mechanical equipment spaces are based on equipment scheduled in each case. Should the Contractor request a substitution for equipment of another make that requires more space in any critical dimension, the Contractor shall submit, together with other submittal data on the equipment, prints of drawings indicating how the equipment may be installed, indicating room for servicing and revisions in piping or ducting and any other details necessary for the Architect to form a judgement as to the suitability of the substitute material, as to performance, suitability for the space and other variables.

B. Duties of certain equipment items, horsepowers of driving motors and electrical characteristics are scheduled for equipment items of a particular make in each case. Should requests for a substitute material be accepted which has other requirements that would involve allied equipment or other portions of work, the Contractor shall be responsible for all modifications required at no change in contract price. As examples:

1. If an accepted pump motor has a brake horsepower requirement above the motor horsepower scheduled, the Contractor shall be responsible for providing a larger motor and heavier drive and any change in size of the protective device, conduit run and conductors serving that motor. The latter shall be extended through an individual branch protective device and branch circuit on through the panel, feeder, feeder protective device, etc.
2. If accepted, water heaters having a different power voltage, phase or breaker size than those on which the heater were based, the Contractor shall be responsible for adjusting electrical service work accordingly.

C. Structural steel members are indicated to provide supports for certain specific sizes and weights of equipment. Should a substitution request involve other equipment, the spacing of the supports shall be varied to suite the equipment. Should the weight or size of a proposed substituted item of equipment require additional supporting steel members, the Contractor shall include documentation of the additional supports in the request for substitution and install them at no change in contract price if the substitution is accepted.

D. Various large apparatus to be installed may require that the apparatus be installed prior to the installation of portions of structural, walls, or door frames. Coordinate the installation of these items to insure that no demolition of general construction is necessary for equipment installation or that the apparatus does not have to be disassembled for installation.

1.16 STORAGE AND PROTECTION OF MATERIALS

A. Store and protect materials and equipment as specified in Section 01 60 00, Product Requirements.

B. Contractor shall provide storage space for protection and storage of his materials and assume complete responsibility for all losses due to any cause whatsoever. All storage shall be within the property lines of the building site, and as directed by the Architect. In no case, shall storage interfere with traffic conditions in any public or project thoroughfare.

C. All work and material shall be protected at all times. Contractor shall make good any damage caused, either directly or indirectly, by his workmen. He shall be responsible for safe handling of all mechanical equipment and shall replace, without charge, all items damaged prior to acceptance by the Owner.

D. On site storage shall not be inside the building during construction progress, but shall be in approved trailers or as specifically approved otherwise by the Architect. Storage inside the building shall only be allowed when so allowed by the Architect.

1.17 FOUNDATIONS

A. Provide equipment foundations associated with the work specified in Division 22.

B. All top corners and edges of all foundations shall be neatly chamfered at a one inch (1") high 45 degree angle.

C. Foundation bolts shall be placed in the forms when the concrete is poured. Allow one inch (1") below the equipment bases for alignment, leveling, and grouting with non-shrinking grout. Grouting shall be done after the equipment is leveled in place. After the grout has hardened, the foundation bolts shall be pulled up tight and the equipment shimmed, if necessary.

D. After removal of the forms, the surface of the foundation shall be rubbed until smooth.

E. Unless otherwise noted, foundations shall be four inches (4") thick for plumbing equipment, unless specifically noted otherwise on the Drawings.

F. All concrete work shall conform to the requirements of Division 03, Cast-in-Place Concrete.

G. Provide housekeeping pads and foundations for every item of floor mounted equipment specified in Division 22 specifications. Pads shall extend a minimum of two inches (2") in each direction beyond the equipment size.

1.18 EXCAVATION AND BACKFILLING

A. Contractor shall do all necessary excavating and backfilling for the installation of his work. Trenches for underground piping shall be excavated to required depths with bell holes provided as necessary to insure uniform bearing. Care shall be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where rock or hard objects are encountered, they shall be excavated to a grade six inches (6") below the lowermost part of the piping and refilled to grade as specified. Installation shall comply with ASTM D2321. After the piping has been installed and reviewed by Architect and local building authorities, trenches shall be backfilled to grade with approved non-expansive materials, well tamped or puddled compactly in place. Where streets, sidewalks, etc., are disturbed, cut, or damaged by this work, the expense of repairing same in a manner approved by Architect shall be a part of this contract.

B. Contractor shall bear sole responsibility for design and execution of acceptable trenching and shoring procedures, in accordance with State of Texas Regulations. On trench excavations in excess of five feet (5') in depth, Contractor shall pay a qualified engineer to prepare detailed Drawings and specifications directing Contractor in the safe execution of trenching and shoring. It is understood that trench safety systems constitute a means and method of construction for which the Architect, Engineer, and Owner are not responsible. Accordingly, such documents when prepared, shall be separately issued by Contractor's Consultant, independent of project contract Documents.

1.19 WIRING

A. Unless otherwise noted, all wiring for motors, starters, and equipment is specified in Division 26.

B. Wiring of temperature controls shall be performed in accordance with the requirements of Division 26 but shall be performed as outlined in other sections of these specifications.

C. All power for control circuits required for the Temperature Control System shall be provided and installed where indicated on the Division 26 Drawings, but shall otherwise be provided as indicated in other sections of these specifications.

D. Each supplier of equipment requiring control shall have wiring diagrams furnished with submittals. This shall be used to determine conduit layouts required to complete the electrical portions of the instrumentation and control systems.

E. All motors furnished as a portion of work specified in Division 22 shall be wired as specified in Division 26.

F. Except where combination starter-disconnects are specified elsewhere herein or in Division 26, all motors shall be provided with safety disconnect switches in accordance with the National Electrical Code as specified in Division 26.

G. Furnish all necessary wiring diagrams for equipment specified in Division 22, as a part of equipment submittals, for installation under other sections of these specifications.

1.20 EQUIPMENT STANDARDS

A. All basic materials and equipment shall be standard catalog products of a reputable manufacturer and shall essentially duplicate equipment which has been in satisfactory service for at least one (1) year.

B. First of a kind new technology devices will not be considered.

C. Accessory equipment that is required to make a complete and functioning system that is not of the same manufacturer furnishing the basic materials or equipment shall carry the guarantee of the basic material or equipment manufacturer and repair and replacement parts shall be available through normal trade channels locally.

1.21 CLEAN UP

A. Contractor shall be responsible for cleaning up after and during all work performed under this Division of the Specifications.

B. Contractor shall, on a daily basis, remove construction trash and debris accumulation to minimize the entrance of dust, dirt, and debris in piping, ductwork, and mechanical equipment.

C. At the completion of construction, just prior to Substantial Completion and sustained operation of equipment, thoroughly clean the inside of piping, ductwork, and equipment.

D. Refer to Division 1.

1.22 FINAL CONSTRUCTION REVIEW

A. Schedule: Upon completion of the work specified in Division 22, there shall be a final construction review of the completed plumbing systems installations. Prior to this walk-thru, all work specified in this Division shall have been completed, tested, adjusted, and balanced in its final operating condition and the preliminary test report shall have been submitted to and approved by the Architect.

B. Personnel: A qualified person representing the Contractor must be present at this final construction review to demonstrate the system and prove the performance of the equipment.

C. Building plumbing systems shall have been in operation for a minimum of 15 days and Test and Balance work shall be substantially complete prior to this review.

D. Exceptions to the aforementioned requirements will be considered on a case-by-case basis dependent on the size and type of project, as well as construction schedule limitations.

1.23 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these Specifications.

B. Provide copies of all applicable approved notices and inspection certifications from the various inspections conducted by the Local Code Enforcement Authorities.

1.24 GUARANTEE

A. The guarantee provision of this specification requires prompt replacement of all defective workmanship and materials occurring within one year of final job acceptance, Substantial Completion, or as defined by Extended Warranty Contracts. This includes all work required to remove and replace the defective item and to make all necessary adjustments to restore the entire installation to its original specified operating condition and finish at the time of acceptance.

B. The Contractor shall also guarantee that the performance of all equipment furnished and installed under this Division of the Specifications shall be at least equal to the performance as called for in the specifications and as stated in the equipment submittals. Should there be indication that the equipment and installation is not producing the intended conditions, the Contractor shall make further tests as the Owner's Representative may direct to demonstrate that the equipment installed meets the specifications and is delivering the capacity specified or called for on the Drawings.

C. If there is any indication that the equipment does not meet the specified quantities, the Contractor shall, at his expense, institute a program to demonstrate the adequacy of the installation. This program shall include all necessary testing and testing equipment. Should the Contractor not have the equipment or technical skill to perform the tests, it shall be his responsibility to employ recognized experts to perform the tests and shall provide certified laboratory tests, certified factory reports and work sheets, or other certified data to support results of any tests required.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING EQUIPMENT AND PIPING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 22 Sections as applicable. Refer to other Divisions for coordination of work with other portions of the work.

1.2 SYSTEM DESCRIPTION

A. Provide a complete system of Piping Identification as specified herein for each of the systems as described herein.

B. Provide a complete system of valve identification by the use of tags as described herein.

C. Provide a complete system of equipment identification tags as described herein.

1.3 QUALITY ASSURANCE

A. The installation of all mechanical system identification devices shall be performed under this Section of the Specifications using materials which are the product of reputable manufacturers. The application of the materials shall be in strict accordance with the published standards of the manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

B. Manufactured Piping Identification markers, equipment name plates and valve tags shall be a product of Seton Name Plate Corporation, EMED Company, Inc., or Craftmark Identification to meet all ANSI Standards pertaining thereto.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions in accordance with Section 22 05 00.

B. Shop Drawings:

1. Submit a list of all piping systems to be identified, color of background to be used, legend or wording to be displayed for each system, and the intended location of all markers to be displayed.
2. Submit a list of equipment to receive identification tags, cut sheets and proof copies of tags which indicate location of tag and wording to be engraved thereon.
3. Submit a list of valves with location, indicate type of service, type of tag, tag number and proposed valve tag chart as specified herein.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 22 05 00.

PART 2 - PRODUCTS

2.1 PIPING IDENTIFICATION SYSTEM

A. Furnish piping identification markers for all insulated and uninsulated piping systems in sizes and colors in accordance with ANSI Standard A13.1. Markers shall be as manufactured by Seton Name Plate Corporation similar to their vinyl plastic "Setmark" pipe markers with flow arrows. For systems with overall outside diameters under 6" use the snap-around markers. For systems with overall diameters 6" and over use strap-around markers attached with nylon ties.

B. Markers shall be provided as a minimum for the following systems:

1. Domestic Cold Water (Green background)
2. Domestic Hot Water (Yellow background)
3. Drains (Green background), for all insulated drains not contained in one space or roof; i.e., an A/C condensate drain in a fan room shall not require identification, whereas, as drain extending to another space would.
4. Storm Sewer (Green background)
5. Sanitary Sewer (Green background)
6. Sprinkler Piping (Red background)
7. Natural Gas (Yellow background)
8. Non-Potable Water (Blue background)

2.2 EQUIPMENT IDENTIFICATION

A. This Contractor shall provide identification plates similar and equal to Seton Name Plates, Style 2060.

B. Name plates shall be a minimum of 1/16" thick and 1" X 3" in size with beveled edges. The surface shall be a black satin with a white core for lettering. Each plate shall be drilled with two mounting holes sized for 3/8" No. 3 round head nickel plated steel screws. Lettering shall be a minimum of 3/16" high. Lettering shall be cut through the black surface to the white core. Only name plates equal to those specified will be considered. No punched plastic tape or engraved aluminum plates are acceptable. Stick-on only plates are not acceptable.

C. Provide and install identification plates on the cover of all starters or disconnects or combination starter-disconnects, where not mounted directly on the equipment, delivered by the mechanical system installer to the electrical systems installer and on each piece of Mechanical Equipment to include but not necessarily limited to:

1. Pumps.
2. Water Heaters.

D. Name plates shall have complete words describing equipment type, use and service. As an example, air handlers shall be designated "AHU-S-X MEP Shop" to designate the equipment as an air handler, number of air handler and area served. Use multiple or larger name plates as required to fulfill this requirement.

2.3 VALVE TAGS

A. Wire onto the handle of each valve installed a 19 gauge brass disc not under one and one-half inches (1-1/2") in diameter stamped with 1/4" high black paint filled letters over 1/2" high black paint filled numbers. Use "PLBG" as letters for Plumbing Valves, "AC" or "HVAC" for Air Conditioning System Water Valves or "FP" for Fire Protection Valves, followed by an identifying number. Tags shall be equivalent to Seton Style 250-BL.

B. Secure valve tags to valves by use of brass "S" hooks or brass jack chains.

C. The number, location, and purpose corresponding to each valve shall be listed in sequence, properly typewritten on a schedule sheet to be turned over to the Owner.

D. Provide two (2) framed valve tag charts with typed schedule sheets contained therein. Charts shall have an aluminum frame with clear plastic or lexan window.

2.4 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

A. Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping or utilities. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3 inches minimum in width, color coded for the utility involved with suitable warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Provide for underground natural gas piping systems.

B. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

PART 3 - EXECUTION

3.1 PIPE MARKER INSTALLATION

A. Provide flow arrows at each marker location.

B. Markers shall be spaced not more than 20 feet on center and at each change of direction but not more than 4 feet in each direction from each elbow and tee. Markers not required on piping runouts less than four feet (4') in length and 1-1/4" or smaller in size.

C. Identification markers shall be installed on all new piping; indoors, outdoors and in the crawl space except for drain and waste lines 3/4" and smaller.

D. Install markers on exposed piping systems only after jacketing systems and finish paint coats are complete. Refer to Sections 09 90 00 and 22 07 00.

E. Provide black painted stencil identification on all new piping concealed above ceilings, in chases, and in a crawl space or tunnel in lieu of markers identified above.

F. Locations of stencils, spacing, and application procedures shall be the same as indicated in Paragraph 3.1B.

3.2 IDENTIFICATION TAG INSTALLATION

A. Secure tags level and in a conspicuous location with adhesive on equipment starters or combination starter disconnects and on the equipment where starters are not immediately adjacent to the equipment served.

B. Additionally, secure all tags with screw fasteners after secured with adhesive.

3.3 VALVE TAGS

A. Secure Valve tags to each valve with Brass "S" hooks or jack chains on each valve stem corresponding to the valve tag chart list.

B. Secure Valve Tag Chart List to Central Mechanical Room wall near the main entry at 60" above finished floor or where otherwise directed by the Architect. Provide second chart to Owner for their disposition.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 22 Sections as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. Provide the systems of insulation which are specified for the control of heat transfer, sound control, and prevention of condensation.

B. Provide protective devices to prevent compression abrasion or puncture of the piping insulation systems installed to include inserts, pipe shields, PVC jacketing and aluminum jacketing as specified herein.

C. Provide piping identification systems as specified in Section 22 05 53, Identification for Plumbing Piping and Equipment.

1.3 QUALITY ASSURANCE

A. The installation of all thermal insulation shall be performed by a single firm regularly engaged in the insulation business, using skilled insulation mechanics and using insulation materials which are the product of reputable manufacturers. The application of the materials by the insulator shall be in accordance with the published standards of the manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

B. Materials shall be manufactured by Schuller, Pittsburg Plate Glass, Owens-Corning, Foster, Certainteed, Mansville, or Knauf.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions to allow review of Materials and Methods to ensure complete compliance with specifications in accordance with Section 22 05 00.

B. Shop Drawings: Submit materials to be used and method of application for each system in tabular form. General statements not specifically identifying means or methods to be used shall be cause for rejection. Include descriptive data and cut sheets on each type of insulation material, sealing method, adhesives used, insert types, shield sizes, and PVC or aluminum jacketing as specified.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Promptly replace all damaged, deteriorated or wet insulation materials.

C. Storage and protection of materials shall be in accordance with Section 22 05 00.

PART 2 - PRODUCTS

2.1 PIPING AND EQUIPMENT INSULATION MATERIALS

A. Domestic Cold and Hot Water Supply, Return, and Non-Potable Water Piping Insulation:

1. Insulation shall be approximately 4 lb. or heavier in density, molded sectional glass fiber pipe covering with factory applied, white FRG, fire resistant, vapor barrier jacket.
2. Insulate valves and fittings with pre-molded glass fiber fitting covers equal in thickness to the adjoining pipe covering. In lieu of pre-molded fitting covers, for welded pipe fittings only, insulate with field fabricated mitered segments of pipe covering equal in density and thickness to the adjoining pipe covering. Use loose low density glass fiber insulation compressed tightly and equal to thickness of adjoining straight pipe sections for screwed fittings; vapor sealed with one 1/8" thick wet coat of water based Foster 30-80, Childers CP-38 vapor barrier coating, or approved equivalent. Vapor barriers- coatings shall adhere to MIL-PRF-19565C and have a maximum permeance rating of 0.013 at 43 mils dry film thickness per ASTM E-96, procedure “B”, or equivalent adhesive, and imbedded in a glass fabric tape which has an emulsion imbedded in it and a coating on it; apply a second 1/8" thick coat of Foster No. 30-80, Childers CP-38 vapor barrier coating, or equivalent adhesive and apply a PVC jacketing as specified elsewhere herein.
3. Finish entire installation with PVC sheet jacketing where exposed from the finished floor up to 12'-0" above the finished floor including all portions of horizontal piping that occurs at and extends above 12'-0". Jacketing shall be applied to all straight piping sections, as well as all elbows, tees, valves, and fittings. Use "smoke-safe" PVC fitting covers, similar to Speedline 1, Knauf “Proto” or John Manville “Zeston 2000". Suitably seal all jacketing seams with tape, or other approved means, along the entire length of seams.
4. Loose "Diaper" inserts at fittings shall not be allowed.
5. Insulation thickness shall be as follows:

PIPING SYSTEMS	INSULATION THICKNESS - INCHES P I P E S I Z E S				
	RUNOUTS 3/4" & SMALLER	LESS THAN 1"	1" TO 1-1/2"	2" TO 3"	4" & OVER
Domestic Cold Water	1.00	1.00	1.00	1.00	1.00
Domestic Hot Water, Hot Water Return Water	1.00	1.00	1.00	1.00	1.00
Non-Potable Water	1.00	1.00	1.00	1.00	1.00
Storm & Overflow Drain	-	-	.5	.5	.5

B. Waste, Drain and Miscellaneous Lines:

1. Insulate the body of each floor and roof drain, where the body of the drain is out of the ground, or above a ceiling, with One-Coat of Insulating Cement, or equivalent, to a 1" thickness and coat with two 1/8" thick coats of Foster No. 30-80, Childers CP-38 vapor barrier coating, or equivalent adhesive, reinforced with an intermediate glass fabric tape saturated with lagging adhesive.
2. Waste lines for E.W.C.'s, floor drains receiving condensate from air handling equipment condensate pans to the point where they join the vertical stack or sanitary main, all horizontal and vertical primary storm drainage piping to the point of penetration to the underfloor and the first vertical piece of the overflow drain pipe (below the drain body) and the first horizontal section of overflow drain piping to the first three feet (3') of vertical pipe beyond that section: Insulate as described for domestic water lines, except the insulation shall be minimum 1/2" thick (use 1" thick where 1/2" thick is unavailable in the pipe sizes needed). Complete vapor seal shall be required.

C. Expansion Tanks and Domestic Hot Water Storage Tanks: Insulate with 2" thick, approximately 4 lb. density fiberglass, pipe or board insulation, rigid, or rigid-scored- for-curvature; carefully cut and/or mitered to fit contours and point up voids and dents with insulating cement. Protect ASME labels from physical damage and being covered with mastic and insulation. Completely expose ASME labels and bevel insulation around such labels and seal exposed cut insulation with mastic. For domestic water system labels provide an "Armaflex" Patch, removable, 1/2" thick. Finish with PVC sheet jacketing similar to piping systems.

D. Plenum Safe Jacketing:

1. Where non-plenum rated piping (such as PVC, FRPP, PE, PP, etc.) is installed in return air plenums cover all exposed portions of this piping with a plenum safe jacketing, or wrap, system that is a factory manufactured and tested non-combustible barrier, to flame and smoke spread, designed to encapsulate non-rated or combustible items located in return air plenums, in accordance with the most recent additions of the International Building and Plumbing Codes.
2. Plenum safe jacketing shall be covered with a light weight fiberglass reinforced foil scrim finished high temperature rated insulation with an approximate density of 6 pounds per cubic foot. Jacketing shall have a Flame Spread and Smoke Developed rating of 0 for the unfaced blanket and be under 25 and 50 respectively for these items as tested in accordance with U.L. 723 and ASTM E-84. Maximum Flame Spread in accordance with U.L.1887 shall be 0 feet. Maximum smoke/optical density and Average Smoke per U.L.1887 testing shall not exceed 01 and 0 respectively. U.L. 1887 test procedure is a modified tunnel test which provides test data for flame spread and smoke density using a single plastic pipe and a bundle of plastic pipes of various sizes subjected to a fire test.
3. Thermal resistance of the barrier system shall be 4.2 as tested in accordance with ASTM C518. The Barrier System shall be able to withstand an operating temperature up to 2,300 Deg.F. and have a melting point of no lower than 3,100 Deg.F.
4. Plenum safe jacketing shall be a minimum 1/2 inch thick and have at least one side covered with a foil skin which must face the outer, or exposed, side. All joints in each direction shall be overlapped a minimum of one inch (1"). Jacket shall be secured tightly around the piping with either stainless steel banding or stainless steel tie wire. Use stainless steel crimp clamps on banding fasteners. Tie wires shall be secured using twist tensioning. Seal all cut edges with aluminum foil tape to ensure there is no exposed fiber.
5. Plenum safe jacketing shall be as manufactured by:

    a. Great Lakes Textiles, Inc. or approved equals by;
    b. 3M Corporation.
    c. Thermal Ceramics.
    d. FryeWrap by Unifrax.

E. Water Filled Drain, Domestic Water and any other Water Filled Lines Exposed to the Outdoors:

1. Protect to -10 degrees F. By wrapping with heat trace wire with thermostata strapped to lines.
2. Then insulate with 1" thick, 4 lb. Or heavier density molded glass fiber jacket covering with FRJ jacket. Insulate fittings same as described earlier herein for chilled and heating water piping.
3. Finally cover with an 0.016" thick aluminum with locked seams and banded joints made watertight. Jacketing shall be equivalent to Childers Aluminum roll jacketing confirming to ASTM B-209, with smooth mil finish.
4. Cover valves, mechanical couplings, and fittings with prefabricated aluminum jacketed fitting covers with factory applied moisture barriers to thickness to match that on piping and band in place. Fitting covers shall be equivalent to Childers ELL-JACS, Tee-Jacs, Flange-JACS, and Valve-JACS. Seal ends to prevent moisture penetration and to make completely weatherproof.

PART 3 - EXECUTION

3.1 GENERAL

A. Apply insulation and pipe covering after all of the piping system to be insulated has been pressure tested, found to be completely tight (without leaks), and accepted as such. All insulated T-handles, blow-down valves, extended handles and caps should be installed prior to commencing with insulation. Verify that control, isolation, and balancing valves and any other piping specialty where a valve stem or test port

extends beyond the normal pipe insulation thickness to be installed is installed pointed upward vertically. Thoroughly clean and dry all surfaces prior to being covered.

B. For operational systems, perform work after operational hours and only during periods of scheduled equipment shutdown. During this period water flow to the piping segments to be insulated shall be stopped and the water and piping shall have equalized in temperature with the average ambient temperature of the space in which the piping is installed. If time does not permit this to occur then apply heat to the piping in a controlled, suitable manner, to warm the water and pipe sufficient to prevent any condensation from occurring during the insulation process. For any segments to be left uninsulated until the next system shutdown, mastic seal the ends and penetrations through of the installed insulation and allow sealant to dry prior to re-energizing the water system. Continue to insulate the piping system in small enough portions after-hours, or as required, to insure no insulation is applied over a wet surface.

C. In the covering of surfaces subject to low temperatures (below 60 Deg. F.), take extreme precautions to secure a complete vapor seal and avoid air pockets of any kind within the insulation. All insulation shall be tightly fitted to the piping system and all systems shall have an equal thickness and density of insulation around all piping, valves, strainers, accessories, etc. Where fiberglass insulation is cut to contour insulation around valves or strainers add additional insulation to obtain the overall insulation thickness specified. Where vapor barrier jackets are lapped at seams and joints, paste such flaps carefully to assure no break in the vapor seal. Seal around butt joints with strips of vapor barrier jacket. Use self-sealing laps on all insulation for pipes carrying a medium below 60 Deg.F. Stapling will not be permitted where vapor barrier jackets are specified. Vapor barriers for these systems shall have a perm rating not to exceed 0.05.

D. On glass fiber pipe covering with factory applied vapor barrier jacket, lap the jacket on the longitudinal seams and seal with vapor barrier lap adhesive equivalent to water based Foster 30-80, Childers CP-38 vapor barrier coating, or approved equivalent. Vapor barriers - coatings shall adhere to MIL-PRF-19565C and have a maximum permeance rating of 0.013 at 43 mils dry film thickness per ASTM E-96, procedure “B”. Tightly butt the ends and cover butt joints with a 4" wide band of vapor barrier jacket secured with the same adhesive. At all run-out piping to water equipment mastic seal the ends of the branch piping insulation where it meets the main piping insulation to prevent the migration of moisture should it ever become trapped in the insulation system. Generally, mastic seal the ends of butt joints in water piping systems every 50 feet for the entire system.

E. Where jacketing systems are specified, use standard weight, PVC sheet rolls. Exercise care to locate seams in an inconspicuous place and apply all jacketing neatly, including that on valves and fittings. Unsightly work will be considered a justifiable basis for rejection. Adhere the jacketing in all cases with a lagging adhesive, Foster 30-36 A F (Anti-Fungal) or Childers CP-137 AF, or other approved methods. Lagging adhesives shall meet ASTM D 5590 with a “0" growth rating.

F. All insulation shall be continuous through wall and ceiling openings and sleeves.

G. All insulation and accessories shall have composite (insulation, jacket and adhesive used to adhere the jacket to the insulation) fire and smoke hazard ratings as tested under procedure ASTM E-84, NFPA 255, and UL 723 not exceeding:

Flame Spread	25
Smoke Developed	50
Fuel Contributed	50

H. No insulation shall be applied to the bodies of unions and flanges on domestic hot water supply and circulating lines only. Terminate the insulation short of the unions or flanges at this equipment, and bevel off at a forty five degree angle to permit "breaking" the union or removal of the flange bolts without damaging the insulation. Bevel the insulation off also at caps on scale pockets, and blow-off connections on strainers, and at valve bonnets on these same systems.

I. Unsightly work shall be cause for rejection, including poor application of adhesives and coatings beyond the insulation which coats valves or other piping specialties.

J. Damage or Modification to Insulation: Where new insulation is disturbed or damaged during the process of installing other new materials, making new connections, etc., it shall be repaired or replaced to return it to its original condition and appearance. Where lines are removed and connections to insulated lines are capped, insulate those caps as well as repairing damaged insulation. Materials shall match those presently installed in thickness, density, insulating value, jacketing, etc.

K. Miscellaneous Lines: Piping connected to water lines through which there might be fluid flow on occasions such as the lines connected to air vents, lines running to compression tanks, etc. shall be insulated as described for other piping in those systems.

L. Hanger and Support Locations: At the location of hangers or supports for pipes run above ground and finished with a vapor seal insulation, provide rigid sections of cork, Foamglas, calcium silicate or high density polyurethane, at least the same thickness as the adjacent insulating material to adequately support the pipe without compression of the insulating material and cover with a vapor seal that is bonded to the adjacent insulation as described for fittings in the lines. Where the insert has an insulating value less than the adjacent pipe insulation the thickness of the insert shall be increased to equal the insulating value of the adjacent pipe insulation. Wood inserts shall not be allowed. Hangers and supports for piping insulation to receive a vapor barrier shall be installed exterior to the insulation.

M. Material Changes: Wherever there is a change in materials on lines that are vapor sealed, apply a suitable adhesive that is compatible with both materials, tapes, etc., as required to maintain the vapor barrier.

N. The following describes materials, thickness and finishes for insulation on piping. In the following "exposed" shall mean any pipe exposed below the finished ceiling and structure where no ceiling is installed, in any room space, area, mechanical rooms, closets, and any pump run exterior to the building, including above the roof. "Concealed" shall mean any pipe located above ceilings, in furrings, in chases, in crawl spaces, and buried in direct contact with the soil.

O. In all "exposed" areas, up to 12'-0" above the finished floor, insulation shall receive a PVC jacketing system. Neatly install all jacketing for finish painting.

P. All insulation materials and jacketing shall exhibit the following characteristics:

1. Water sorption, per ASTM C 1104, shall be less than 0.02%.
2. Linear shrinkage, per ASTM C 356, shall be negligible.
3. Stress corrosion, per ASTM C 795, shall not cause corrosion.
4. Corrosiveness, per ASTM C 665, shall not be any greater than sterile cotton.
5. Resistance to fungi, mold and mildew and bacteria, per ASTM C 665, shall be rated as not promoting growth of fungi and bacteria. Inhibitors shall be added to specified products to meet these requirements.

3.2 SHIELDS AND INSERTS

A. Metal saddles, shields, shall be applied between hangers or supports and the pipe insulation. Saddles shall be formed to fit the insulation and shall extend up to the centerline of the pipe and the length specified for hanger inserts. Shields shall be made of galvanized sheet metal and shall be of sufficient size and length to prohibit the crushing of the insulation materials. Saddle shields shall be as follows:

Pipe Size	Metal Saddles	
	Metal Gauge	Length
3/4" to 3"	18	12"
4" to 6"	16	12" - 18"
8" to 10"	14	24"
12" & Larger	12	24"

B. Provide inserts of calcium silicate on hot piping and cellular glass or 7#/Cu.Ft. fiber glass pipe insulation on cold piping at hangers except pipes 1-1/2" or smaller in size. Inserts between the pipe and pipe hangers shall consist of rigid pipe insulation of a thickness equal to the adjoining insulation and shall be provided with vapor barrier where required. Insulation inserts shall not be less than the following lengths:

Pipe Size	Insert Length
3/4" to 3"	12"
4" to 6"	12" - 18"
8" to 10"	24"
12" & Larger	24"

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING SYSTEM

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - General Requirements and referenced documents.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide a complete system of domestic hot and cold water supply as indicated herein and as illustrated on the contract drawings.

B. Provide isolation of systems through valving as shown or indicated herein.

C. Provide a system free of water hammer.

D. Isolate all piping components to eliminate all audible vibration and noise.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01.

B. Indicate on submittal piping material and joining method for each system and for the various sizes of piping systems to be installed. This shall be in tabular form in one location.

C. Product Data:

1. Pipe.
2. Fittings.
3. Joining methods.
4. Shock arrestors.
5. Hose bibbs.
6. Hydrants.
7. Backflow preventers.
8. Trap primer.

D. Certification: Submit certification that completed system complies with sterilization procedures and test requirements of municipality, State, and other public authorities having jurisdiction over system sterilization.

E. Submit copies of pressure test data of water systems to Owner prior to time of final completion of construction work.

F. Provide closeout documents as required in Division 1, Section 01 17 00.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:

1. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing.
2. Provisions specified in this Section.
3. International Plumbing Code.

B. Installer shall have been doing related work as described herein for a minimum of 5 years.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Above ground:

1. 3 Inch and Smaller:

a. Pipe: Hard drawn copper water tube, ASTM B88, Type "L".
b. Fittings:

1) 3 Inch and smaller, wrought copper solder joint fittings, ANSI B16.22.

c. Joint solder:

1) 95% tin - 5% antimony for pipe sizes 2" and less.
2) Or 95.5% tin, 4% copper and 0.5% silver based for pipe sizes 2" and less.
3) "Silfos" for pipe sizes 2-1/2" and larger.
4) No lead containing solder is allowed.

B. Underground 5'-0" beyond exterior of building:

1. 3 Inch and Smaller:

a. Piping: Hard drawn or annealed copper tube, ASTM B88, Type K.
b. Fittings: Wrought copper solder joint fittings, ANSI B16.22
c. Joint solder: "Silfos" only, no lead containing solder allowed.

C. Underground piping within 5'-0" exterior of building:

1. 2 Inch and Below:

a. Pipe: Annealed copper coils, ASTM B88, Type K.
b. Fittings: No fittings allowed below slab.

2. 2-1/2 Inch to 3 Inch:

a. Pipe: Annealed copper tube, ASTM B88, Type K.
b. Fittings: No fittings allowed below slab.

D. Unions:

1. 3 Inch and Smaller: ANSI B16.22 wrought copper; solder end fittings.

E. Valves and Supports: Provide lead-free bronze full-port ball valves with stainless steel trim for pipe sizes 2-1/2" and smaller. Butterfly valve are not allowed. Refer to Section 22 05 00 and 22 21 13, Basic Materials and Methods.

2.2 SPECIALTIES

A. Access Doors:

1. Milcor "Style K, M, or DW", stainless steel to suit surface application.
2. Panels to have cam locks and door sized 18 inches by 18 inches
3. All restroom/toilets and kitchen areas shall have stainless steel access doors.

B. Shock Arrestors:

1. Acceptable manufacturer: Sioux Chief Manufacturing Co., Precision Plumbing Products (PPP), Josam, Jay R. Smith.
2. One piece, seamless copper construction.
3. Piston type, triple "O" ring copper construction.

4. Factory charged.
5. Plumbing Drainage Institute (PDI) certified.
6. ASSE 1010 approved with lifetime warranty, not requiring access.
7. Size as shown on drawings or as recommended by manufacturer.
8. Acceptable product: "Hydra-Rester", Sioux Chief Manufacturing Co.

C. Air Chambers: Same material and size as pipe branch or riser; minimum of 18" long.

D. Vacuum Breakers:

1. Acceptable manufacturer:
    a. Watts.
    b. Febco.
    c. Beeco.
2. Atmospheric, check valve type.
3. Bronze body construction with polished chrome finish.

E. Reduced Pressure Type Backflow Preventer Assembly:

1. Acceptable manufacturers:
    a. Watts.
    b. Apollo
    c. Ames.
2. Double check valve type with shutoff valves.
    a. Quarter turn ball shut-off valves up to 2-1/2 Inches.
    b. Outside stem and yoke gate shut-off valves 3 Inches and over.
3. Differential pressure type relief valve with air gap fitting.
4. Lead-Free bronze body construction up to 2-1/2 Inches.
5. Cast iron body construction 3 Inches and over.
6. Provide in-line upstream y-type strainer.
    a. 20 mesh strainer 2 Inches and below.
    b. 0.125 perforated screen mesh 2-1/2 Inches and over.
7. Acceptable Product: Watts No. 909S (FDA)-QT.

F. Double Check Backflow Preventer Assembly:

1. Acceptable manufacturers:
    a. Watts.
    b. Apollo
    c. Ames.
2. Double check valve type with shutoff valves.
    a. Quarter turn ball shut-off valves up to 2-1/2 Inches.
    b. Outside stem and yoke gate shut-off valves 3 Inches and over.
3. Lead-Free bronze body construction up to 2-1/2 Inches.
4. Cast iron body construction 3 Inches and over with stainless steel internal ports and FDA approved fused epoxy coating.
5. Provide in-line upstream y-type strainer.
    a. 20 mesh strainer 2 Inches and below.
    b. 0.125 perforated screen mesh 2-1/2 Inches and over.
6. Acceptable Product: Watts No. 709S (FDA)-QT.

G. Hose Bibbs Within Mechanical Rooms or Unfinished Building Space: 3/4" chrome plated brass compressed cocks; hose connection; key handle, lock shield, vacuum breaker; Chicago No. 998 or No. 952, as required; or equivalent by T&S Brass or Woodford.

H. Non-Freeze Roof Hydrant: 3/4" NPT male brass nozzle hose thread freezeless roof hydrant with 304 stainless steel shroud and base, 125 pound 7" globe angle valve, quick disconnect with built-in vacuum breaker, under deck flange, drain down reservoir utilizing the “Venturi Principle”, and black powder coated cast aluminum weather-guard dome handle. MAPA Model MPH-24FP.

I. Wall Hydrants - Exposed Non-Freeze Wall Hydrant with Integral Vacuum Breaker: Josam #71000-74-95 cast bronze hydrant with satin nickaloy scoriated with cylinder vandalproof lock face, integral backflow preventer. "T" handle key, and bronze casing with 3/4" universal inlet connection.

J. Trap Primer:

1. Automatic Trap Primer shall be designed to deliver potable water to floor drains. The trap primer shall operate from a solenoid activated every 24 hours. Trap primer shall be operated to automatically maintain a constant water seal in P-traps. Where required by Local Authorities Having Jurisdiction, provide indirect connection between automatic trap primers and trap primer line that connects directly to drain body or p-trap.
2. TP-1: Trap primers serving floor drains in all other spaces shall be solenoid operated, with proper distribution unit where required. Precision Plumbing Products, Inc., Mini-Prime Electronic Trap Primer Model MP-500 (115V/24V/220V). Coordinate electrical connection to solenoid.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

B. All piping shall be properly cleaned and reamed to the full inside diameter of the pipe size prior to joining.

C. Connections to Equipment:

1. Install necessary pipe connections and fittings required to connect equipment.
2. No rough-in shall be done before drawings of equipment are received.
3. Make all final connections to include unions or flanges to facilitate future removal.
4. Install cutoff valves on equipment connections.

D. Install shock arrestor ahead of each quick closing valve, at top of each riser and on pipe run to water closets as recommended by manufacturer. Shock arrestors shall be accessible as required by Local Codes.

E. Install backflow preventers at connections to closed mechanical water system makeup such as chilled water and hot water systems and beverage dispenser connections as required by Local Codes.

F. Pressure reducing valve assembly shall be installed as required when city water supply pressure exceeds 80 psig at the building domestic water header.

G. Trap Primer Lines cast in concrete floor or below slab shall be continuous Type "K" copper tubing. No joints shall be allowed below floor. Insulate copper tubing with 1/2" insulation below slab, polywrap copper tubing, or provide approved coating to prevent contact between copper and concrete when cast in floor or structure. Slope trap primer line continuously. No piping shall be cast in structural members unless noted on plans and approved by Structural Engineer.

H. Strictly coordinate locations of wall clean out cover plates and access doors. Submit locations to the Architect prior to installation for final approval.

3.2 FIELD QUALITY CONTROL

A. Testing:

1. Furnish instruments, equipment, and labor necessary to conduct tests.
2. Methods of sampling, inspecting, and testing shall conform to local codes.
3. Tests of plumbing systems:
    a. Plumbing piping systems shall be pressure tested.
    b. Underground piping shall be tested and successfully repaired prior to backfilling.
4. Water Systems:
    a. When rough-in is completed and before fixtures are set, entire hot and cold water and piping systems shall be tested at hydrostatic pressure of not less than 100 psig, and approved tight at this pressure for not less than 30 minutes.
    b. Where portion of water piping system is to be concealed before completion, portion shall be tested separately as specified for entire system.
5. Domestic hot water circulating system: Balance and check prior to final inspection and provided with sufficient thermometers installed at time of final construction review to prove that water is circulating in all piping loops to fixtures.
6. Defective work:
    a. If inspection or test shows defects, defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated.
    b. Repairs to piping shall be made with new materials.
    c. No caulking of screwed joints or holes will be acceptable.

B. Disinfection:

1. After pressure tests have been made and leaks repaired, flush entire domestic water distribution system with water until entrained dirt and mud have been removed.
2. On the building side of each water meter assembly, provide a minimum 3/4 inch connection for injection of sterilizing fluid to disinfect the piping system chlorinating materials utilizing liquid chlorine or calcium hypochlorite shall be used.
3. Provide dosage of not less than 50 parts per million.
4. Retain treated water in pipe long enough to destroy all non-spore forming bacteria.
5. Retention time shall be at least 24 hrs. and shall produce not less than 10 ppm of chlorine at extreme end of system at end of retention period.
6. Open and close valves in system being disinfected several times during contact period.
7. Flush system with clean water until residual chlorine is reduced to less than 1.0 ppm versus 0.2 at the most remote fixture.
8. During flushing period, open and close valves and faucets several times at several locations.
9. From several points in system, take samples of water in properly disinfected containers for bacterial examination.
10. Repeat disinfecting until satisfactory bacteriological results have been obtained and City Health Dept. has made final approval of test.

3.3 ADJUSTING AND CLEANING

A. Equipment, pipes, and valves shall be cleaned of grease, metal cuttings, and sludge that may have accumulated from operation of system during test.

B. Stoppage, discoloration, or other damage to finish, furnishing, or parts of building, due to failure to properly clean piping system, shall be repaired.

C. When work is complete, adjust hot water systems for uniform circulation.

D. Adjust flush valves and automatic control devices for proper operation

END OF SECTION

SECTION 22 11 23

NATURAL GAS PIPING SYSTEM

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

C. Comply with Local Governing Gas Codes, and the requirements of the Authorities Having Jurisdiction.

1.2 SYSTEM DESCRIPTION

A. Provide a complete natural gas piping system as indicated herein and as illustrated on the contract drawings.

B. Make connections to water heaters, HVAC equipment, kitchen equipment or other devices as specified here or as shown on the drawings.

C. Provide gas cocks, pressure regulators, dirt legs, valves and unions or other devices as indicated and as required by the local authorities having jurisdiction.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 1.

B. Indicate on submittal piping material and joining method for each system and for the various sizes of piping systems to be installed. This shall be in tabular form in one location.

C. Product Data:

1. Pipe.
2. Fittings.
3. Joining methods.
4. Valves.
5. Clean Gas pressure regulators.
6. Vents.

D. Certification: Submit certification that completed system complies with test requirements of municipality, State, and other public authorities having jurisdiction over system.

E. Provide closeout documents as required in Division 1.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:

1. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.
2. Provisions specified in this Section.
3. Applicable provisions of standards of National Fire Protection Association (NFPA).
4. Applicable provisions of standards of American Gas Association (AGA).
5. International Plumbing Code and Gas Code.
6. Local Gas Utility Requirements.

B. Installer shall have been doing related work as described herein for a minimum of 5 years.

PART 2 - PRODUCTS

2.1 MASTER METER

A. Contractor shall coordinate revised gas service requirements with the Local Natural Gas Utility Company to insure the timely provision of this service to keep up with the project requirements. Coordinate exact pipe routing, size, installation, and system pressure requirements with utility company. Contractor shall coordinate with and pay all costs to the Utility Company for all new gas piping from the off-site gas main trunk connection up to the property line, extended onto the site up to and including the gas meter installation at the proposed location. Contractor shall install gas piping from the gas meter up to the building entry point. This system shall be provided with the service pressure noted with isolation valves, test ports, and regulation components to adjust the downstream pressure to that indicated.

B. Contractor shall furnish to the local gas utility company a detailed itemized list of all gas fired equipment including required operating supply pressure and MBTU input requirement of each piece of equipment.

2.2 ABOVE GROUND PIPE AND FITTINGS

A. Pipe: ASTM A53, Grade A or B, seamless, Schedule 40, standard weight black steel.

1. 2 Inches and Smaller: Threaded and coupled.
2. 2-1/2 Inches and Larger: Butt welded joints
3. All gas piping in sleeves shall have welded joints, regardless of size.

B. Fittings, 2 Inches and Smaller: ASTM A197, 150 LB black malleable iron, screwed joint. Piping system with pressure of 2 psig or greater shall have socket welded joints for all sizes.

C. Fittings, 2-1/2 Inches and Larger: ASTM A234, WPB standard weight, weld joint fittings.

D. Unions, 2 Inches and Smaller: ASTM A197, 150 LB, black malleable iron, screwed joint, brass to iron ground joint.

E. Flanges:

1. Use for 2-1/2 Inches and larger pipe.
2. ASTM A181, Grade 1, 150 LB, flat faced, weld neck.
3. Gaskets:

a. Acceptable manufacturers:

1) Manville.
2) Cranite.

b. 150 LB, 1/16 Inch full-faced, punched sheet, 650 Deg.F. rating suitable for gas service.
c. Bolting: ASTM A307, Grade B, heavy hex head machine bolt with heavy hex nuts.

2.3 UNDER GROUND PIPE AND FITTINGS BEYOND THE BUILDING EXTERIOR

A. Polyethylene Pipe: ASTM D2513, D2683, and D3261, Type PE 2306; SDR 9.3 through 21.

B. Fittings: Socket and butt type, thermally bonded.

C. Joints: Thermally bonded heat fusion joints.

D. Tracer Wire: Seton underground gas line warning tape, yellow color with "Caution - Gas Line Buried Below" continuously labeled, minimum 0.004 inch thick polyethylene, with metallic core, two inches wide.

E. Service Riser: Schedule 40 pre-bent galvanized steel riser with transition and protective coating and anode as detailed on the Drawings. Provide anodeless service riser where required by Local Authorities.

2.4 VALVES

A. Acceptable Manufacturers:

1. SMG Global
2. Milwaukee
3. Hammond
4. McDonald.

B. Valves: 125 LB iron cocks, flat head, non-lubricated plug with resilient double seal, screwed ends or flanged, for natural gas service.

C. Acceptable Product: "Series 400", Key Port valve by SMG Global with RS49 (HYCAR) plug seals, U.L. listed for natural gas shut-off.

2.5 GAS PRESSURE REGULATORS

A. Acceptable Manufacturers:

1. Rockwell/Equimeter.
2. Itron
3. Fisher.
4. American Meter.

B. Regulators:

1. Adjustable type, with automatic loading.
2. Provide with automatic pressure relief.
3. Provide means for removing and renewing valve.
4. Adjust for outlet pressure required.
5. Outlet pressure shall not vary more than 1/2 inch water column from setting point at connected load capacity for regulator.

C. Pressure Relief: Diaphragm operated, spring loaded type with vent for relief of excess pressure on low pressure side of each main service regulator.

D. All equipment shall be furnished with final regulator.

E. Regulators shall have bug-proof screened vent cap installed in vent tapping.

F. When regulators are installed inside the building and venting of the regulator is required, extend the vent full size to the outside and terminate vent with a gooseneck with a bugproof screen.

G. Acceptable Product: Rockwell Model 143, 243 or 121 as determined by inlet and outlet pressure, pipe size and CFH capacity.

H. Provide secondary regulators at individual equipment connections where required to deliver manufacturer’s recommended delivery pressure to equipment.

2.6 GAS PIPE SLEEVES

A. Inside Building:

1. Schedule 40 black steel, ASTM-A-53.

2. Mitered and welded joints:

B. Exterior underground:

1. Schedule 40 PVC.
2. Solvent weld joints.
3. Terminate vent sleeve above ground with Schedule 40 galvanized steel, gooseneck with bug proof screen.

2.7 VENT CAPS

A. Caps shall be weatherproof with bug-proof screened vent.

B. Caps shall be double outlet vent cap, slip-on type with set screw or threaded, with aluminum body and 40 mesh stainless wire cloth as manufactured by Morrison Bros. Co., OPW or Universal.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Cap or plug pipe openings during installation.

B. Cover and protect piping, fixtures and equipment against dirt, water, weather, and chemical or mechanical injury.

C. Run Piping Concealed and Sleeved in Finished Rooms unless Indicated Otherwise:

1. Terminate lower end of vertical supply piping near burners or equipment connections.
2. Terminate with tee, nipple, and cap to serve as dirt trap.
3. Where gas burning kitchen equipment is located adjacent to other gas burning kitchen equipment, provide manifold for battery.
4. Connect each end of a manifold to gas distribution system to maintain uniform gas pressure at each piece of equipment, two (2) point service.
5. All final equipment connections shall consist of a union and shut-off valve.

D. Threaded Joints:

1. Taper threads and cut evenly; make with graphite and oil.
2. After cutting and before threading, ream pipe to remove burrs.
3. Use appropriate pipe joint thread compound.
4. Caulking of threaded joints after joining to stop or prevent leaks will not be permitted.

E. Welded Joints:

1. Fusion-weld in accordance with ANSI B31.8, make changes in direction of piping with welding fittings only.
2. Mitering or notching pipe to form elbows and tees will not be permitted except for sleeves as indicated elsewhere herein.
3. Make branch connections with welding tees or forged welding branch outlets except for sleeves as indicated elsewhere herein.

F. Beveling:

1. Make field and shop bevels by mechanical means or flame cutting.
2. Where beveling is done by flame cutting, clean surfaces of scale and oxidation prior to welding.

G. Alignment:

1. Before welding, align component parts to be welded so no strain is placed on weld when finally positioned.
2. Set flanges and branches true.
3. Maintain alignment during welding operation.

H. Make final connection to equipment using rigid pipe and fittings.

I. Place fire stop where pipes pass through fire walls, fire partitions, or floors.

J. Underground Pipe Coatings: Refer to Section 22 05 00 and Local Gas Codes.

K. Sleeves:

1. Install continuous pipe sleeve around gas piping above ceilings, in vertical chases, and at all concealed piping within the building.
2. Seal all sleeves airtight inside the building except where noted, and allowed by Authorities Having Jurisdiction, to terminate in ventilated space.
3. Vent all sleeves to the outside. Terminate sleeve to prevent entrance of water and insects.
4. Size and install gas pipe sleeves to permit replacement of gas piping without damage to building structure.
5. Terminate gas sleeve vents a minimum of eight inches (8") above the roof with specified vent cap. All exposed vent piping on roof or above grade shall be Schedule 40 galvanized steel pipe.
6. Vent to have free area equal to the net free area between the sleeve and the largest gas pipe contained therein.
7. All gas piping in sleeves shall have welded joints regardless of pipe size.
8. Where the end sealing is capable of withstanding the full pressure of the gas pipe the vented sleeve shall be designed for the same pressure as the pipe.

L. Underground Pipe Coatings: Refer to Section 22 05 00 and Local Gas Codes.

M. Piping on roof:

1. Piping shall be supported on roof supports furnished and installed under Division 07 of the Architectural specifications and as recommended by the roofing manufacturer at a spacing not to exceed 10'-0" on center and within 3'-0" of each equipment connection or branch pipe.
2. Offset pipes to be 8" minimum above the roof at all expansion joints, roof penetrations, perimeter gravel stops/fascia and vertically flashed surfaces.
3. Unless noted otherwise, bottom of pipe shall be minimum of 4" above roof or roof ballast.
4. Do not secure piping to supports unless detailed otherwise.
5. Exposed piping shall be coated with red primer and a minimum of two coats of paint. Preparation of piping and painting shall comply with other applicable sections in Division I.
6. Pipe installer shall determine exact layout of piping and locate all required supports.

3.2 FIELD QUALITY CONTROL

A. Set up in accessible position, where directed, test pump and mercury gauge connected to permanent gas piping.

B. Protect pump and gauge and keep in working order until after final inspection.

C. Remove as directed.

D. Before appliances are connected, piping systems shall withstand a test pressure of 150 percent of the maximum working pressure or 30 PSIG, whichever is greater, for a period of not less than one (1) hour without showing a drop in pressure.

E. Pressure calibrated instruments shall read in increments of not greater than 0.1 LB when measured with mercury manometer or slope gauge.

F. Pressurize system, then isolate source of pressure before pressure tests are made.

G. Test gas piping with dry air only.

H. If test fails, repair all leaks and retest until the test passes.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT SYSTEM

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - General Requirements and referenced documents.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide a complete sanitary waste and vent system as indicated herein and as illustrated on the contract drawings.

B. Make connections to grease traps, oil interceptors, sewage ejectors, sump pumps or other devices as specified here or as shown on the drawings.

C. Provide trap primer connections on floor drains or other devices as indicated and as required by the local authorities having jurisdiction.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 30 00.

B. Indicate on submittal piping material and joining method for each system and for the various sizes of piping systems to be installed. This shall be in tabular form in one location.

C. Product Data:

1. Pipe.
2. Fittings.
3. Joining methods.
4. Floor drains.
5. Clean outs.

D. Certification: Submit certification that completed system complies with test requirements of municipality, State, and other public authorities having jurisdiction over system.

E. Provide closeout documents as required in Division 1, Section 01 70 00.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:

1. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.
2. Provisions specified in this Section.
3. International Plumbing Code.

B. Installer shall have been doing related work as described herein for a minimum of 5 years.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Schedule 40 PVC Piping Above & Below Grade:
1. Pipe 1-1/2 - 8 inches: Poly Vinyl Chloride (PVC) schedule 40, drain waste vent (DWV) pipe, ASTM D2466, ASTM D 2321, ASTM D2665 and ASTM 1785, NSF stamped and approved. System shall be rated for 200 psi minimum pressure.
2. Fittings 1-1/2 - 8 inches: Poly Vinyl Chloride (PVC) schedule 40, DWV patterned fittings, ASTM D2466 and ASTM 1784, NSF stamped and approved.
3. Solvent Cement: Shall comply with pipe and fitting manufacturer's recommendations and shall be a two (2) step process with Primer manufactured for thermoplastic piping systems and solvent cement per manufacturer and shall conform to ASTM D2564 and ASTM F656.

a. PVC pipe material shall not be allowed to serve fixtures, drains, or equipment subject to receiving fluids with temperatures of 140 Deg.F. or higher. Provide cast iron service weight pipe and fittings as specified above and extend a minimum of 20' (twenty feet) or to main waste line to assure high temperature cools in cast iron pipe before entering PVC piping material.

B. Below Slab: (WASTE WATER DISCHARGE IS 140 DEG. OR GREATER – KITCHEN – GREASE WASTE)

1. Cast Iron Piping:

a. Pipe 1-1/2 Inches through 10 Inches: CISPI 301, or ASTM A888, service weight, no hub cast iron pipe, coated with coal tar pitch.
b. Fittings 1-1/2 Inches through 10 Inches: CISPI 301, or ASTM A888, service weight, no hub cast iron fittings with coal tar pitch coating.
c. Pipe 12 Inches and larger: ASTM A74, service weight, cast iron, single hub, coated with coal tar pitch.
d. Fittings 12 Inches and larger: ASTM A74, service weight, cast iron, hub and spigot fittings, coated with coal tar pitch.
e. All cast iron soil pipe and fittings shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI) and be NSF Internationally listed.

2. Cast Iron Soil Pipe Joints:

a. Pipes with hubs: Provide neoprene compression gasket seals ASTM C564.
b. Hubless pipe: Provide 28 gauge stainless steel shield and clamp assembly over one piece neoprene sealing sleeve, Clamp-All "HI-TORQ 80", or Husky HD-2000.
c. Joint Restraints (Pipe Sizes 4" and larger):

1) For no-hub short and long sweep 1/4 bend pipe restraints contractor shall provide engineered pipe restraints. These shall be engineered to prevent pipe separation due to dynamic movement within the piping system in both the longitudinal and diagonal. Restraints shall be galvanized and equal to HoldRite #117 Series restraints

2.2 CLEANOUTS

A. Acceptable Manufacturers:

1. Model numbers specified are products of Jay R. Smith, unless otherwise specified.
2. Other acceptable manufacturers:

a. Josam.
b. Wade.
c. Zurn.
d. Watts.

B. Size: Same size as pipe up to 4 Inches; 4 Inch for 4 Inch and larger pipe.

C. Cleanouts for Cast Iron Pipe: Tapped extra heavy cast iron ferrule, caulked into cast iron fittings.

D. Cleanout Plugs:

1. Meet requirements of Plumbing Code, with American Standard pipe threads.
2. Taper thread bronze plug.
3. Or neoprene gasket seal ABS plug.

E. Cleanouts do not require special covers on lines in completely accessible pipe chases or in equipment rooms where piping is exposed.

F. Pipe Fittings at Cleanouts: Make cleanouts turning out through walls and up through floor by long sweep ells or "Y" and 1/8 bends.

G. Cleanout Cover Plates:

1. Provide face or deck plates for concealed cleanouts to conform to architectural finish in room.
2. Where no definite finish is indicated, wall plates shall be stainless steel and floor plates Nickel Bronze.
3. Provide vandalproof screws.

H. Acceptable Products:

1. In floor with Linoleum tile or vinyl tile finish:

   a. Round Nickel Bronze top.
   b. Scoriated top.
   c. Smith No. 4053L-NB-U.

2. In floor with ceramic tile finish:

   a. Square Nickel Bronze top.
   b. Scoriated top.
   c. Smith No. 4053L-NB-U,

3. In finished rooms flush with wall:

   a. Vandal Proof Stainless Steel Center screw.
   b. Cleanout tee with Stainless Steel Round Cover.
   c. Smith No. 4533-SS-U.

4. In fan or mechanical room floors with concrete finish and/or with floating floors:

   a. Round Nickel Bronze Extra Heavy Duty top.
   b. Secured Scoriated top.
   c. Smith No. 4113L-NB-U.

5. In floors with carpet:

   a. Continuous Carpet: Round Nickel Bronze top with Nickel Bronze Carpet Clamping Device (-X).
   b. Carpet Squares: Round Nickel Bronze Scoriated top below carpet with screwed Stainless Steel Carpet Cleanout marker (-Y).
   c. Smith No. 4033L-Y-NB-U or 4033L-X-NB-U.

6. For terrazzo floor finish:

   a. Round Nickel Bronze top.
   b. Scoriated top.
   c. Smith No. 4053L-NB-U.

7. Exposed Stack:

   a. Duco Coated Cast iron cleanout "tee".
   b. Gasket Sealed countersunk bronze plug.
   c. Smith No. 4513S-Y-U.

8. Underfloor Chase:

    a. Cast Iron Cleanout body.
    b. Gasket Sealed countersunk bronze plug.
    c. Smith no. 4292L-U.

9. Vehicle Traffic Outside Grade:

    a. Duco Coated Heavy Duty Cast Iron Round Cleanout Housing.
    b. Soriated Cast iron Cover with Lifting Device.
    c. Vandalproof screws.
    d. Cast iron cleanout ferrule and Gasket Seal Bronze Plug.
    e. Smith No. 4262L-U.

10. Grade:

    a. Duco Coated Extra Heavy Duty Cast Iron Top.
    b. Installed in concrete block 18" x 18" x 6", or surround each cleanout with a minimum of four inches (4") of concrete by six inches (6") thick, top of block shall be flush with finished grade.
    c. Smith No. 4232L-U.

2.3 DRAINS

A. Acceptable Manufacturers:

1. Josam.
2. Jay R. Smith.
3. Wade.
4. Zurn.
5. Watts.

B. P-traps:

1. Provide floor and equipment drains with cast iron P-traps.
2. Provide deep seal traps where indicated, or as required.

C. Trap Primer Connections: Where indicated or shown on the drawings provide a trap primer connection on the body on the P-trap of each drain of the size indicated.

D. Clamping Collars: When installed with waterproofing membrane, or shower pans, provide floor drains with clamping collar.

E. Floor Drains/Sinks:

1. Floor Drain "FD-1" - For Finished Areas: Smith No. 2005-A06NB-U, cast iron body with cast iron collar, adjustable six inch (6") round secured satin finish bronze strainer, vandalproof screws, and bottom outlet. Provide Smith No. 3510-F1107NB cast iron body and cast iron collar, adjustable seven inch (7") round nickel bronze strainer, and four inch (4") round nickel funnel for drains that receive indirect waste piping from equipment or fixtures. Provide six inch (6") square top strainer size for Square Ceramic Tile Floors. Smith No. 2005-B06NB.
2. Floor Drain "FD-2": Smith No. 2350 Duco coated cast iron body floor drain, adjustable eight point five inch (8.5") round top, loose set anti-tilting grate, perimeter drainage slots, flashing collar with weepholes, bottom outlet, and suspended sediment bucket. Provide Smith No. 3650-B cast iron body with cast iron grate and collar six inches (6") round grate and 9" x 3-1/2" cast iron funnel for drains that receive indirect waste piping from equipment or fixtures.
3. Floor Drain "FD-3": Kitchen Floor Drain: Josam 43450-VP fabricated 304 stainless steel body with stainless steel drain, flashing clamp, weeping channel, with 8” vandal-proof anti-tilt adjustable stainless steel grate and rim.
4. Hub Drain (H.D.): Set cast iron bell flush with finished surface, unless otherwise noted. Equal to Sioux Chief 832-4DHHD with debris screen.
5. Floor Sink "FS-1": Smith No. 3150Y-13-C cast iron body flanged floor sink with acid resistant coated interior and dome strainer, minimum eight inches (8") deep, twelve inch (12") square top, double drainage flange, weepholes, bottom outlet, Nickel Bronze Rim and Secured Nickel Bronze 3/4 grate

F. Trench Drain:

1. Acceptable manufacturer: ABT, PolyDrain or Smith/ ACO Polymer Products. Equal to Smith 9930 with catch basin 9935
2. Precast polymer concrete interlocking channel of tongue and groove channel shall have built-in 0.06 percent slope with integral metal railing..
3. Channel shall have interlocking ribs for locking channel into floor slab, 6” wide, Class C loading.
4. Channel grate: Heavy duty stainless steel; secured by built-in locking system Equal to Smith ACO 9870-455-SSHD.
5. With Catch Basin - Smith No. 9935-BP w/ stainless grate – 9870-455-SSD.
6. TD-1, Trench section 1-12 – 12N – 12-1.

2.4 EQUIPMENT

A. Oil/Water Separator – Interior Installation:

1. Acceptable manufacturer:

   a. Park Environmental, Inc.- Elevadar ES Series

2. Welded 3/16” carbon steel vessel for above ground installation conforming to ASTM A36 with internal coalescing media pack. All components shall be epoxy coated or corrosion resistant. Unit shall be capable to flowing 50 gpm per elevator cab.
3. Meet local municipal requirements.

B. Solids Interceptor (Shall be installed on commercial disposals unless otherwise directed by the AHJ):

1. Acceptable manufacturer:

   a. Jay R. Smith
   b. Josam
   c. Zurn

2. Floor mounted all aluminum body with gasketed cover, flush type lift and locking devices, fabricated sediment strainer and removable stainless steel screens.
3. Jay R. Smith – 8710T-AA

2.5 VENT PIPE ROOF PENETRATION FLASHING

A. Flash each vent pipe roof penetration as recommended by the roofing system manufacturer as specified under other sections of the specifications.

B. Where vent pipes pass through the roof and no indication is made elsewhere in other sections of the specifications as to flashing requirements, use 4 lb. per Sq. Ft. minimum; seamless sheet lead rolled over the vent pipe to counter flash pipe.

C. When lead flashing is required under the conditions noted in the above paragraph comply with the following:

1. 24 Inches square minimum size at base of lead flashing.
2. 8 Inches minimum clear on all sides of pipe.

D. Install vandalproof vent caps similar to Smith No. 1748 to be the same size as vent pipes passing through the roof.

2.6 GREASE INTERCEPTOR

A. Construct as detailed on the Drawings, or provide a precast concrete grease trap. Grease trap shall have a capacity of 1,500 gallons and be designed for a flow rate of 150 gpm. Provide basin extension as required for cover to be flush with final finished grade. Provide gas tight gasketted cast iron manhole frames & covers. Grease trap shall be as manufactured by Brooks Precast, Arlington, Texas; American Industrial Precast Products, Inc., Burleson, Texas; or Park Equipment Company, Houston, Texas. Pipe

grease interceptor as detailed on the Drawings and in compliance with Local Codes and Authorities having jurisdiction. Sample well shall be RCP concrete with AASHTO-H20 cast iron lid, 4" inlet/outlet with drop and 15" diameter opening by Park Environment USA, SWB-154.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Each plumbing fixture shall be individually trapped and vented with vent and waste stacks full size throughout.
2. Install reducers, increasers, special flanges and fittings between piping and fixtures for complete installation, ready for use.
3. Make offsets necessary to avoid construction interferences.
4. Connect plumbing fixtures, drains, appurtenances, and appliances to receive or discharge liquid waste or sewage to sanitary waste system in accordance with requirements of local codes.
5. Protect seal of fixture trap in plumbing system with properly installed vent.
6. Coordinate floor drain locations with Drawings and other trades.
7. Manhole covers shall be sealed gas tight. Provide gasketted seal as recommended by manufacturer.

B. Slope:

1. Slope horizontal drainage lines 2 inches and smaller 1/4 In per foot toward main sewer.
2. Slope 3 inch and larger drainage lines 1/8 inch per foot
3. Horizontal drain lines shall be run in straight lines uniformly sloped.
4. Make changes in direction of flow of horizontal lines with wye and 1/8 bends.

C. Vents:

1. Extend vents above roof without reduction in size and terminate not less than 25 feet away from shaft, windows, or ventilating air intake openings.
2. All vent and branch vent pipes shall be graded and connected to drip back to sanitary waste pipe by gravity.
3. Extend vent lines at least 6 inches above flood level rim of vented fixture before offsetting.
4. Extend all vents minimum of 24 inches above roof.
5. Offset vents in outside walls to penetrate roof at least 18 inches from outside walls.
6. Extend roof vent flashing onto roof surface minimum of 8 inches on all sides in accordance with the roofing system manufacturer's recommendations.
7. Coat metal sheet flashing with bituminous mastic where in contact with mortar or concrete to prevent direct contact with masonry materials.

D. Traps:

1. Equip each fixture, floor drain or piece of equipment connected to sanitary waste system with a trap.
2. Plumbing fixtures, except those having integral traps, shall be separately trapped by water seal P-traps placed as close to the fixture outlet as possible.
3. Provide trap with cleanout.
4. No fixture shall be double trapped.

E. Cleanouts:

1. Install in each change of direction greater than 90 degrees, at end of lines, base of risers, and other points necessary to permit cleaning of pipe sections.
2. Cleanouts shall be readily accessible.
3. Extend cleanouts on concealed piping through and terminate flush with wall, floor, or grade. Strictly coordinate cleanout cover plate location with the Architect for approved locations prior to pipe installation.
4. Space cleanouts not more than 50 feet apart for 3 inch pipe or less and not more than 100 feet apart for 4 inch and larger pipe.
5. If local requirements are more stringent than those indicated herein then those shall govern.

6. Cleanouts located at restroom batteries and/or at water closets shall be installed 12 inches above the flood rim of the water closet.

F. Drains:

1. Install floor, area, and equipment drains flush in the floor or basin to be drained unless indicated otherwise.
2. Locate drains in mechanical equipment spaces to conform with drain locations of equipment furnished.
3. Coordinate drain locations for Food Service equipment with rough-in drawings for such.
4. Coordinate with other trades to insure floors are sloped toward floor or area drains to provide positive drainage.

G. Coordinate installation of vent flashing for all roof penetrations with other sections of the specifications.

3.2 FIELD QUALITY CONTROL

A. Furnish instruments, equipment, and labor necessary to conduct tests.

B. Test underground soil and waste piping before backfilling.

C. Test drainage, waste, and venting piping with water before fixtures are installed.

D. After plumbing fixtures have been set and traps filled with water, submit entire drainage, waste, and venting system to final test with smoke.

E. Water Test:

1. Apply water test to drainage, waste, and venting system either in its entirety or in sections.
2. If entire system is tested, tightly close openings in pipes except highest opening.
3. Fill system with water to point of overflow.
4. If system is tested in sections, each opening except highest opening of section under test shall be tightly plugged.
5. Fill each section with water and test with at least 10 foot head of water.
6. In testing successive sections, at least upper 10 feet of next preceding section shall be tested so that each joint of pipe in building except uppermost 10 feet of system has been subjected to test of at least 10 foot head of water.
7. Keep water in system or in portion under test for at least 60 minutes before inspection starts.
8. Repair any leaks discovered during test.
9. Repeat test until system holds water for six (6) hours without drop in water level.

F. Final Smoke Test: At the completion of project where new sanitary sewer piping is installed and/or existing sanitary sewer piping is modified, the entire sanitary sewer system for the facility shall be tested as indicated below. Eagle Mountain - Saginaw ISD construction manager shall be notified (2) days in advance of when the test shall occur. Contractor shall document testing procedures, start time and time of completion. This information shall be included into the O & M manuals as part of the final close out documents.

1. Produce smoke by smoke machine.
2. Maintain pressure equal to 1 inch water column for 15 minutes before inspection starts.
3. Repair leaks discovered during test.
4. Repeat test until system holds smoke for ten (10) minutes without showing leaks.

G. Camera TV Video Recording of all main Sanitary Sewer lines in and under the Building (By General Contractor).

1. General Contractor shall contract with a Third Party Plumbing Testing firm experienced in provide video camera inspection of all existing and new underground storm sewer lines within the building to verify that there are no obstructions found.

END OF SECTION

SECTION 22 14 00

STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - General Requirements and referenced documents.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide a complete storm drainage system as indicated herein and as indicated on the contract drawings.

B. Provide an area drainage system within and to 5 feet outside building line or as otherwise indicated on the drawings.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 30 00.

B. Indicate on submittal piping material and joining method for each system and for the various sizes of piping systems to be installed. This shall be in tabular form in one location.

C. Product Data:

1. Pipe.
2. Fittings.
3. Joining methods.
4. Roof Drains.
5. Area Drains
6. Sub-Soil

D. Certification: Submit certification that completed system complies with test requirements of municipality, State, and other public authorities having jurisdiction.

E. Provide closeout documents as required in Division 1, Section 01 17 00.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:

1. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing.
2. Provisions specified in this Section.
3. International Plumbing Code.

B. Installer shall have been doing related work as described herein for a minimum of 5 years.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Piping above and below slab and buried in grade:

1. Piping: Polyvinyl Chloride (PVC) Schedule 40, drain waste vent (DWV) pipe; ASTM D2466, ASTM D2321, ASTM D2665 and ASTM D1785, NSF stamped and approved. System rated for 200 psi minimum pressure.
2. Fittings: PVC Schedule 40 (DWV) ASTM D2665 NFS stamped and approved.
3. Solvent Cement: Shall comply with pipe and fitting manufacturer's recommendations and shall be a two (2) step process with Primer manufactured for thermoplastic piping systems and solvent cement per manufacturer and shall conform to ASTM D2564 and ASTM F656.

B. Subsoil Drain Pipe:

1. Corrugated, polyethylene perforated and non-perforated, high density corrugated pipe with internally smooth interior and drainage pattern fittings. Joints shall be made with split couplings, corrugated to insure a minimum of four corrugations, two on each side of the pipe joint.
2. ASTM D-1248
3. Provide a polyester envelope "sock" on the entire piping system.
4. Acceptable Product: Equal to Type N-12 pipe as manufactured by "ADS", Advanced Drainage Systems.

2.2 ROOF DRAINS

A. Acceptable manufacturers:

1. Model numbers specified are products of Zurn, unless otherwise specified.
2. Other acceptable manufacturers:

   a. Josam.
   b. Jay R Smith
   c. Wade.
   d. Watts

B. Roof Drain (RD) – Low Profile:

1. Duco coated cast iron body with combined clamping ring and gravel stop; no hub outlet; drain receiver with underdeck clamp, adjustable extension collar and vandalproof cast iron dome.
2. Acceptable product: Zurn Z100-NH-ZC-C-SC-VP.

C. Emergency Overflow Roof Drain (OD):

1. Same as standard roof drains except with adjustable internal water collar for drains with (2") two inch - (6") six inch outlet, set not more than two inches (2") above the primary roof drain flood level or Same with cast iron external 2" two inch high clamping collar for drains with (8") eight inch and (10") outlet.
2. Acceptable product: Zurn Z100-NH-ZC-C-SC-VP-W2.

2.3 DOWNSPOUT NOZZLE

A. Josam 25020-Z, stainless steel downspout nozzle, loose wall flange and threaded connection.

2.4 AREA DRAINS

A. Area Drain AD-1:

1. Duco coated cast iron body and flashing clamp with seepage openings and Vandal Proof Square Ductile Iron Under grate with Heel Proof Nickel Bronze Veneer. Grate Openings must be 3/8" or smaller.
2. Acceptable product: Smith no. 1410Y-NBM-C-HP-U

2.5 DOWNSPOUT BOOTS

A. Downspout boots for connection to underground storm system shall be constructed of cast iron, cast aluminum or 304 stainless steel with one coat of rust inhibited primer applied at the factory, inlet shall match sheet metal gutter downspout dimensions, 6" diameter outlet, 60" long stock length.

B. Refer to Architectural Plans for quantities and installation details.

C. Secure boot per manufacturer's recommendations.

D. Acceptable Products: JR Hoe, N-Series, Piedmont B1 Series, Barrycraft B25C Series or Jay R Smith

2.6 CLEANOUTS

A. Acceptable Manufacturers:

1. Josam.
2. Jay R. Smith.
3. Wade.
4. Zurn.
5. Watts

B. Size: Cleanouts shall be same size as pipe up to 4 Inches; 4 Inch for 4 Inch and larger pipe.

C. Cleanouts for Cast Iron Pipe: Tapped extra heavy cast iron ferrule, caulked into cast iron fittings.

D. Cleanout Plugs:

1. Meet requirements of Plumbing Code, with American Standard pipe threads.
2. Gasket Seal bronze plug.

E. Cleanouts do not require special covers on lines in completely accessible pipe chases or in equipment rooms where piping is exposed.

F. Pipe Fittings at Cleanouts: Make cleanouts turning out through walls and up through floor by long sweep ells or "Y" and 1/8 bends.

G. Cleanout Cover Plates:

1. Provide face or deck plates for concealed cleanouts to conform to Architectural finish in room.
2. Where no definite finish is indicated, wall plates shall be stainless steel and floor plates nickel bronze.
3. Provide vandalproof screws.

H. Acceptable Products:

1. In floor with Linoleum tile or vinyl tile finish:

   a. Round Nickel Bronze top.
   b. Scoriated top.
   c. Smith No. 4053L-NB-U.

2. In floor with ceramic tile finish:

   a. Square Nickel Bronze top.
   b. Scoriated top.
   c. Smith No. 4053L-NB-U,

3. In finished rooms flush with wall:

   a. Vandal Proof Stainless Steel Center screw.
   b. Cleanout tee with Stainless Steel Round Cover.
   c. Smith No. 4533-SS-U.

4. In fan or mechanical room floors with concrete finish and/or with floating floors:

   a. Round Nickel Bronze Extra Heavy Duty top.
   b. Secured Scoriated top.
   c. Smith No. 4113L-NB-U.

5. In floors with carpet:

a. Continuous Carpet: Round Nickel Bronze top with Nickel Bronze Carpet Clamping Device (-X).
b. Carpet Squares: Round Nickel Bronze Scoriated top below carpet with screwed Stainless Steel Carpet Cleanout marker (-Y).
c. Smith No. 4033L-Y-NB-U or 4033L-X-NB-U.

6. For terrazzo floor finish:

a. Round Nickel Bronze top.
b. Scoriated top.
c. Smith No. 4053L-NB-U.

7. Exposed Stack:

a. Duco Coated Cast iron cleanout "tee".
b. Gasket Sealed countersunk bronze plug.
c. Smith No. 4513S-Y-U.

8. Underfloor Chase:

a. Cast Iron Cleanout body.
b. Gasket Sealed countersunk bronze plug.
c. Smith no. 4292L-U.

9. Vehicle Traffic Outside Grade:

a. Duco Coated Heavy Duty Cast Iron Round Cleanout Housing.
b. Soriated Cast iron Cover with Lifting Device.
c. Vandalproof screws.
d. Cast iron cleanout ferrule and Gasket Seal Bronze Plug.
e. Smith No. 4262L-U.

10. Grade:

a. Duco Coated Extra Heavy Duty Cast Iron Top.
b. Installed in concrete block 18" x 18" x 6", or surround each cleanout with a minimum of four inches (4") of concrete by six inches (6") thick, top of block shall be flush with finished grade.
c. Smith No. 4232L-U.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install roof drains, reducers, increasers, flanges, and fittings between piping and drains in accordance with manufacturer's recommendations.
2. Make offsets necessary to avoid construction interferences.
3. Protect piping from damage and corrosion.
4. Connect drains receiving water to storm drain system of building.
5. Coordinate precast trench and other types of grating system installations with Drawings.
6. Horizontal pipe and fittings six inches (6") and larger shall be suitably braced to prevent horizontal movement. This shall be done at every branch opening or change of direction by the use of braces, blocks, rodding, or other suitable methods, to prevent movement. Consult pipe manufacturer's recommendations for approved methods.

B. Slope:

1. Horizontal drainage lines 2 inches and smaller: Slope minimum 1/4 inch per foot toward main sewer.
2. Horizontal drain lines 3 inches and larger: Slope minimum 1/8 inch per foot toward main sewer.
3. Run horizontal drain lines in straight lines at uniform slopes.
4. Make changes in direction of flow of horizontal lines with Y and 1/8 bends.

C. Cleanouts:

1. Install in each change of direction 90 Degrees or greater, end of lines, base of risers and other points necessary to enable cleaning out of pipe sections.
2. Cleanouts shall be readily accessible.
3. Extend cleanouts on concealed piping through and terminate flush with wall, floor, or grade.
4. Cleanouts shall be not more than 50 feet apart for 3 inch and smaller pipe, and not more than 100 feet apart for 4 inch and larger pipe.

D. Insulation:

1. Provide insulation on body of roof drains and overflow drains, per Section 15250.
2. Provide insulation for all horizontal roof drain piping to a minimum of 3' from top of vertical riser concealed in chase. Extend insulation to crawl space where risers are exposed.

E. Perforated subsoil drain piping shall be installed in continuous length around perimeter of building and tee into non-perforated subsoil drain line and drained to sump.

3.2 FIELD QUALITY CONTROL

A. Furnish instruments, equipment, and labor necessary to conduct tests.

B. Methods of sampling, inspecting, and testing shall conform to local codes.

C. Test underground storm drainage piping before backfilling.

D. Test storm drainage piping with water.

E. Submit drainage system to final test with smoke.

F. Water Test:

1. Apply water test to entire system or in sections.
2. If entire system is tested, tightly plug openings in pipes except highest opening.
3. Fill system with water to point of overflow.
4. If system is tested in sections, tightly plug openings except highest opening of section under test.
5. Fill section with water to 10 foot head of water.
6. In testing successive sections, upper 10 feet of next preceding section shall be tested so that each joint of pipe in building except uppermost 10 feet of system has been subjected to test of 10 foot head of water.
7. Keep water in system or in portion under test for one hour before inspection starts.
8. System shall than be made tight at all joints.
9. Repair leaks.
10. Repeat test until system holds water for six hours without drop in water level.

G. Final Smoke Test:

1. Produce smoke by smoke machine with pressure equivalent to 1 inch water column maintained for 15 minutes before inspection starts.
2. Repair leaks.
3. Repeat test until piping system holds smoke ten minutes without showing leaks.

H. Camera TV Video Recording of all main Storm Drain lines in and under the Building (By General Contractor).

1. General Contractor shall contract with a Third Party Plumbing Testing firm experienced in provide video camera inspection of all existing and new underground storm sewer lines within the building to verify that there are no obstructions found.

END OF SECTION

SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - General Requirements and referenced documents.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other portions of the work.

1.2 SYSTEMS DESCRIPTION

A. Provide a complete sump pump system as indicated herein and as indicated on the Drawings.

B. Provide connections to drainage system as otherwise indicated on the Drawings.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 17 00.

B. Indicate on submittal piping material and joining method for each system and for the various sizes of piping systems to be installed. This shall be in tabular form in one location.

C. Product Data:

1. Pipe.
2. Fittings.
3. Joining methods.
4. Pumps.
5. Controls.
6. Pump Performance Curves and Dimensions

D. Certification: Submit certification that completed system complies with test requirements of municipality, State, and other public authorities having jurisdiction.

E. Provide closeout documents as required in Division 1, Section 01 17 00.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:

1. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing.
2. Provisions specified in this Section.
3. International Plumbing Code.

B. Installer shall have been doing related work as described herein for a minimum of 5 years.

PART 2 - PRODUCTS

2.1 ELEVATOR PIT SUMP PUMPS:

A. Provide simplex submersible sump pump for commercial drainage applications. Pumps shall be furnished with perforated steel plated suction strainer and discharge connection. Pumps, end bells, and motor constructed of cast iron NEMA 6; motor shall be hermetically sealed capacitor start with built-in overload

protection; size as scheduled on the Drawings. Bronze impeller, Series 300 stainless steel shaft, factory sealed grease lubricated ball bearings. Components of mechanical seal shall be stainless steel, ceramic, brass, and Buna-N. Pump furnished with 15 feet of power cable and sensor cable. High level alarm and simplex pump control panel is not required.

B. Simplex submersible sump pumps shall be as scheduled on Drawings.

C. Installation shall be as defined on the Drawings and in compliance with the State Elevator Codes.

D. Coordinate with Electrical Contractor for power supply requirements.

E. Submersible sump pump with two inch (2") discharge able to pass one-half inch (1/2") solids shall be equal to Weil Series 1400.

F. Provide mercury float switch for sensing controls. Provide quantity and location elevation for proper pump operation.

2.2 PUMPED STORM SEWER PIPING

A. Discharge piping off of pumps shall be Schedule 40 galvanized steel pipe with either grooved ends with drainage pattern fittings and Victaulic Style 75 grooved connections, or threaded ends with ASTM-A126 galvanized threaded fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install reducers, increasers, flanges, and fittings between piping and pumps in accordance with manufacturer's recommendations.
2. Provide 3/4" fill line to sump basin with in-line manual fill and trap primer assembly for automatic fill of pit to insure periodic operation of sump pumps.
3. Install pumps per manufacturer's recommendations. Pumps shall be installed for easy access for maintenance and removal.
4. Coordinate with Electrical Contractor to provide necessary power and conduits as noted and detailed on Drawings.
5. Make offsets necessary to avoid construction interferences.
6. Protect piping from damage and corrosion.
7. Coordinate precast or poured in place sump pits with other trades for installations.

3.2 FIELD QUALITY CONTROL

A. Furnish instruments, equipment, and labor necessary to conduct tests.

B. Methods of sampling, inspecting, and testing shall conform to local codes.

C. Test sump pump and piping before backfilling.

D. Water Test:

1. Apply water test to entire system or in sections.
2. If entire system is tested, tightly plug openings in pipes except highest opening.
3. Fill system with water to point of overflow.
4. If system is tested in sections, tightly plug openings except highest opening of section under test.
5. Fill section with water to 10 feet head of water.
6. In testing successive sections, upper 10 feet of next preceding section shall be tested so that each joint of pipe in building except uppermost 10 feet of system has been subjected to test of 10 feet of system has been subjected to test of 10 feet head of water.
7. Keep water in system or in portion under test for one hour before inspection starts.

8. System shall be made tight at all joints.
9. Repair leaks.
10. Repeat test until system holds water for six hours without drop in water level.

END OF SECTION

SECTION 22 21 13

PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 22 Sections, as applicable. Refer to other divisions for coordination of work with other portions of Work.

1.2 SYSTEM DESCRIPTION

A. Furnish and install all piping of every kind required, specified, or shown on the Drawings for the installation of the work specified in Division 22. The location, direction, and size of the various lines are indicated on the Drawings. Lines for pilot and controls and instrumentation are not shown but shall be installed as required and as specified.

B. Piping systems shall include all appurtenances shown on the drawings and specified herein.

C. Valves or cocks shall be installed to control the flow of water to each of the various systems, to segregate individual items of equipment and parts of fluid circulating or supply systems, and to permit draining of systems or portions thereof, to blow-off strainers, etc., as directed on the Drawings and specified.

D. The work shall include the furnishing and installing of all supporting structures and members for pipes, ducts, and equipment.

E. Support devices and members shall include vibration and noise isolating devices and assemblies. Penetrations of walls to structure shall be sealed off to limit noise transmission through sleeves.

F. All material shall be manufactured in the United States and/or shall comply with the North America Free Trade Agreement, NAFTA.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed by experienced mechanics certified and trained for the work performed.

1.4 SUBMITTALS

A. Product Data: Submit complete manufacturer's descriptive literature and installation instructions in accordance with Section 01 33 00 for all piping materials to be used for each system, valves and plumbing specialties as specified herein.

B. Shop Drawings:

1. Submit in accordance with Sections 01 33 00 and 22 05 00.
2. Submit 1/4" = 1'-0" Plumbing Piping Shop Drawings.
3. Overlay piping Shop Drawings over other Shop Drawings of other trades to include electrical and sheet metal Shop Drawings.
4. Plan views of congested areas and sections thereof shall be drawn at a scale of 3/8" = 1'-0".
5. There is a minimum $150.00 fee, payable to the engineer to obtain Auto Cadd files for this purpose. A “Release of Liability” form must be signed after which a single CD will be produced when payment is received.

C. Fully coordinate all piping shop drawings with sheet metal shop drawings and other trades. Failure to submit shop drawings in a timely manner, as required to keep pace with the construction and work of all other trades, will result in delays, and possible stoppage, of payment to the Contractor. Additionally, no work may proceed until such shop drawings are submitted, reviewed, and found to be acceptable by the Engineer.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 22 05 00.

C. Take special precautions to protect control valve internals from construction dirt and debris. If valves are stored on site cover valve openings until just prior to installation but in no case shall valves be unprotected for more than 48 hours.

D. Openings in piping system, boilers, pumps, valves and other heat exchangers shall be covered during the construction period to protect the interior accumulation of dirt and debris in these systems until immediately prior to connection to these components to similarly protected systems.

PART 2 - PRODUCTS

2.1 FLANGES

A. Flanges in welded lines for water systems shall be 150 pound forged steel, welding neck flanges, except where cast iron fittings are used as specified elsewhere in these specifications, and except as otherwise shown.

B. Flanges in screwed ferrous lines shall be 125 pound cast iron or 150 pound forged steel screwed flanges.

C. Where ferrous flanges connect to flat faced flanges on valves, items of equipment, etc., the companion flange shall be flush faced and where the flanges on items of equipment are raised face flanges, the companion flanges shall have raised faces.

D. Flanges in copper lines shall be solder joint type cast brass flanges.

E. Flange bolts and nuts shall conform to the applicable requirements of the latest edition of the Code for Pressure Piping.

F. Slip-on welding neck flanges are prohibited.

G. Flanges shall be Weldbend, Tube Turn, Hackney, or approved equals.

2.2 GASKETS

A. Install gaskets between flanges of all flanged joints. Where used with brass or bronze flanges or with flat face ferrous flanges, they shall be full face type. For all other flanges they shall be ring gaskets properly cut to fit within the inside edges of the bolts.

B. Gaskets in water lines shall be Garlock No. 24 Wire Insertion Red Rubber Sheet Packing, 1/16" thick and for any other systems use special materials suitable for the duty as recommended by their manufacturer.

2.3 INSULATING FITTINGS

A. Except that no dielectric fitting shall be installed in connections between copper or brass and sanitary cast iron waste, drain and vent lines, wherever an interconnection is made between ferrous pipes or vessel and copper tubing or brass pipe, or vice versa, install a dielectric fitting.

B. In lines assembled with screwed or soldered joints, use insulating couplings (unions) suitable for the intended service and where flanged connections are required, use insulating gasket material between flange faces, insulating grommets between bolts and holes in flanges and insulating washers under both bolt heads and nuts.

C. PVC couplings of any kind shall not be acceptable for insulating couplings.

D. Insulating fittings shall be suitable for the service medium, operating pressure and temperature. Fittings shall be rated for 1.5 times the normal system operating temperature and pressure in which installed.

E. Insulating fittings shall be as manufactured by EPCO, Maloney, or Crane.

2.4 VALVES

A. All valves of any one type shall be of the same make throughout and insofar as practicable all valves in a given category shall be of the same make.

B. All valves shall be so located as to be readily accessible for operation and maintenance.

C. Furnish and install all valves indicated on the Drawings, specified herein, and required to control the flow of water to and from various parts of the systems and to isolate various pieces of machinery and equipment and to isolate various parts of the systems.

D. Each valve for installation in a line to be insulated shall have sufficient clearance between the valve body and the operating handle or device to accommodate the insulation.

E. All valves shall be designed for re-packing under pressure when fully opened and shall be equipped with packing suitable for the service.

F. Valves shall generally be installed with stems up; but, in no case, less than horizontal and whenever possible shall be grouped together in a uniform manner.

G. Except where special valves are specified elsewhere herein or as required by special conditions or class of work, valves shall be equivalent to the following Nibco Co.valve numbers listed herein.

H. All valves used for domestic water service shall be Lead-Free per the “Safe Drinking Water Act”. U.S. Senate Bill S. 3874.

I. Where cocks are required, they shall generally be brass, screwed pattern up to 2" and cast iron flanged pattern 2-1/2" and larger plug cocks suitable for the system pressure. Also provide and install all special cocks required such as pet cocks, gauge cocks, etc.

J. Provide Lead Free plug valves where indicated, at "all water balance stations" and at all pump discharges.

1. In no case shall butterfly or ball valves be substituted for plug valves where plug valves are indicated on the Drawings.
2. Valves shall be flanged-type, 2-1/2" and larger, and threaded 2" and smaller.
3. Plug valves 4" and smaller shall be equal to DeZurik Series 400 eccentric plug valves with cast iron bodies.
4. Plug valves over 4" in size shall be equal to DeZurik Series 100 eccentric plug valves with cast iron bodies.
5. Valves 4" or smaller shall have cast iron bodies with bronze plugs on sizes 2" and smaller and electroless nickel plated cast iron plugs on 2-1/2" to 4" valves.
6. Valves over 4" shall have cast iron bodies with stainless steel plugs and bearings.
7. All plugs shall have resilient faces rated for water temperatures up to 250 Deg.F. and stem seals meeting the same temperature rating. For general chilled and heating water applications, elastomeric coating shall be EPDM.
8. Furnish lever operator for all valves except at water coils of terminal units where snap-on plastic caps shall be furnished.
9. All valves shall have adjustable memory stops with plastic drip caps.

10. Plug valves shall be furnished with drilled and tapped 1/8" openings for pressure gauge connections at both upstream and downstream sides.
11. Plug valves shall be bubble tight with 150 pound differential pressure across the seat.
12. An indicator shall be included to show valve position.
13. All flanged plug valves shall have bolted bonnets.
14. All valve seats shall be welded in nickel for plug valves over 4" in size.
15. Plug valves shall be as manufactured by:

    a. SMG.
    b. McDonald.
    c. Rockwell-Nordstrom.
    d. Milliken.

K. Lead Free Check valves in pump discharge lines shall be flanged non-slam type silent check valves. Valves shall have a bronze body and be bronze fitted with stainless steel springs. Valves shall be rated for 125 PSIG WOG and be one of the following products:

1. Nibco - 480 Series, or equal by
2. Apollo 61LF-100.
3. Hammond UP943 or UP947.

L. Lead Free Swing Check Valves 2" and smaller shall be the Y-pattern swing-type manufactured in accordance with MSS-SP 80, and be Class 125 rated to 200 degrees F or below, have bronze ASTM B-62 bodies with bronze discs. Swing check valves 2" and smaller shall be of the following:

1. Nibco - T/S-413-B.
2. Apollo 161 T/S-LF.
3. Milwaukee UP509 or UP1509.
4. Hammond - UP904 or UP912.

M. Lead Free Swing Check valves 2-1/2" and larger shall be the swing-type manufactured in accordance with MSS-SP71, be Class 150 rated for 200 degrees F. or below, be flanged, have ASTM A126, Class B, cast iron bodies with bronze trim, and have non-asbestos gaskets. Swing Check valves 2-1/2" and larger shall be one of the following:

1. Nibco - S-433-B, or equal by
2. Apollo.
3. Milwaukee.
4. Hammond.

N. Bronze Lead-Free Ball valves: 2” and Smaller:

1. Ball valves shall be on the following products:

    a. Nibco T-585-66-LF or S-585-66-LF.
    b. Apollo 77CLF-140 Series.
    c. Hammond UP8301A or 8311A.

2. Ball valves may also be used in lieu of plug valves for balancing purposes for lines 2" and smaller and only when provided with memory stops.
3. Ball valves shall be full port design with stainless steel ball and stem.
4. All ball valves shall be manufactured from a dezincification resistant material with less than 15% zinc.
5. Provide memory stops where used for balancing or as shown and where detailed.
6. Provide extended lever handles for all valves installed in insulated lines.
7. Ball valves installed on water piping shall be provided with an extended "T" handle with insulation insert and collar that creates a vapor seal to prevent condensation while allowing adjustment of memory stops and valve packing maintenance without disturbing the insulation. Insulated "T" handles shall be equal to Nib-Seal as manufactured by NIBCO. No extended metal handles are allowed.

O. Flanged FDA Approved Lead-Free Ball valves: 2½” and Larger:

1. Ball valves shall be on the following products:
    a. Watts G4000M1.
    b. Apollo 77LF-140 Series (2 ½”-4”).
    c. Apollo 6PLF
2. Ball valves shall be full port design with stainless steel ball and stem.
3. Ball valves shall be manufactured with FDA approved epoxy coating.

P. Lead Free Automatic Balancing Valves

1. ThermOmegaTech – “Circuit Solver Assembly” CSUA or CSUA-PP with integral spring check valve. Stainless steel self-contained fully automatic thermal flow control device. Assembly shall be provided with lead-free full port bronze ball valves, integrated union and internal spring check valve.

Q. Provide Venturi splitter valve with integral isolation valves, unions, EPDM seals at locations within the domestic hot water supply system to maintain domestic hot water loop temperatures and supply within required distances as listed with the IECC. Acceptable product: Kemper – KHS-651-06 Series.

R. All valves, valve packing material, gaskets, pipe threading compound, etc., shall be compatible with ethylene glycol, without exception. Typically, use EPDM valve packing materials. No teflon materials are allowed. Indicate compliance on submittals.

2.5 PIPE HANGERS

A. Pipe hangers, except for fire protection types, shall be as manufactured by Anvil International, Inc. and be of a type suitable for each use. Approved equals by Mason Industries, Inc., B-Line, Grinnell, and PHD Manufacturing, Inc. will be considered.

B. For cast-iron pipes up to three inches (3") in size, use Anvil Fig. 104 malleable iron, adjustable, split ring, swivel hanger, or Anvil Fig. 590 steel clevis hanger. For cast iron plumbing piping four inches (4") and larger, use only Anvil Fig. 590 steel clevis hanger.

C. For PVC, CPVC, PVDF, Polyproplene pipe sizes up to three inches (3") ini size, use Anvil FIG. 104 malleable iron, adjustable, split ring, swivel hanger, or Anvil FIG. 590 Steel Clevis hanger. For sizes four inches (4") and larger, use only Anvil FIG. 590 Steel Clevis hanger.

D. Domestic cold and hot water piping 3/4" in size up to and including twelve inches (12"), shall be Anvil Fig. 260, adjustable clevis hangers. Hangers shall be sized to be on the outside of the insulation.

E. Where several pipes are routed parallel to each other and at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on rollers where rollers are called for elsewhere by these specifications.

F. For bare copper pipes (uninsulated only) up to and including three inches (3") in size, use Anvil Fig. CT-109 malleable iron, copper plated, split ring, hangers or Anvil Fig. CT-65 copper plated clevis hangers. For uninsulated copper pipes larger than three inches (3"), use Anvil Fig. CT-65 copper-plated clevis hanger.

G. Hanger rod sizes shall conform to the following schedule:

Pipe up to, and including 2"	3/8" rods
Pipe 2-1/2", 3", and 3-1/2"	1/2" rods
Pipe 4" and 5"	5/8" rods
Pipe 6"	3/4" rods
Pipe 8", 10" and 12"	7/8" rods
Pipe 14", 16" and 18"	1" rods
Pipe 20" up to 30"	1-1/2" rods

H. Unless shown otherwise on the Drawings, all horizontal runs of steel piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to, and including 1-1/4"	8 feet
Pipe 1-1/2" and 2"	10 feet
Pipe 2-1/2" and 3"	12 feet
Pipe 3-1/2" and 4"	12 feet
Pipe 5" and 6"	*8 feet
Pipe 8" and larger	*8 feet
* Maximum 8 foot spacing for pipe supports for pipes 5" and larger due to structural considerations.	

I. Unless shown otherwise on the Drawings, all horizontal runs of cast-iron piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to, and including 1-1/4"	5 feet
Pipe 1-1/2" and 2"	*5 feet
Pipe 2-1/2" and 3"	*5 feet
Pipe 3-1/2" and 4"	*5 feet
Pipe 5" and 6"	*5 feet
Pipe 8" and larger	*5 feet
* Maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.	

J. Unless shown otherwise on the Drawings, all horizontal runs of “Poly” thermoplastic type piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to, and including 1-1/4"	4 feet
Pipe 1-1/2" and 2"	4 feet
Pipe 2-1/2" and 3"	4 feet
Pipe 3-1/2" and 4"	4 feet
Pipe 5" and 6"	4 feet
Pipe 8" and larger	4 feet

K. Unless shown otherwise on the Drawings, all horizontal runs of copper piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to 3/4" in size	6 feet
Pipe 1" and 1-1/4"	8 feet
Pipe 1-1/2" and 2"	10 feet
Pipe 2-1/2" and larger	12 feet

L. There shall be a hanger within two feet (2') for any ferrous or copper piping and eighteen inches (18") for any “poly” thermoplastic type pipe of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps. Vertical pipes within a space shall have not less than two (2) supports. Where the vertical run of pipe in a space exceeds 14 feet then three (3) supports shall be required.

M. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting; nor shall it be supported from equipment connections.

N. Inserts shall be used where piping or equipment is to be hung from concrete construction. Inserts shall be Anvil Fig. 281, wedge type, concrete inserts. All inserts shall be pre-treated to prevent rusting. After the forms are removed, clip off all nails flush with the exposed surface of the inserts.

O. Expansion bolts shall be Ackerman-Johnson.

P. Beam clamps suitable for the use with the type of steel construction involved shall be an Anvil product or an approved equal as indicated elsewhere herein.

Q. No perforated straps shall be used to support any mechanical equipment item or piping of any kind.

R. Potable and non-potable domestic cold water, domestic hot water (includes recirculated lines), horizontal and vertical storm drain downspouts and soil piping receiving cold condensate piping hangers shall be sized to go around the insulation with shields being provided to protect the insulation. Shields shall be Anvil Fig. 167.

S. All steel hangers, base plates, supports, nuts, bolts, and all thread rod located outdoors, in crawl spaces, and exposed to the weather, shall be made of galvanized steel or equally suitable corrosion resistant

steel alloy or aluminum. Where steel components are allowed and used under these conditions they shall be painted with an equivalent protective coating similar to a two-part epoxy. Refer to Section 09 90 00.

T. For pipe sizes 8" and under use Anvil Fig. #93 and 94 beam clamps. For pipe sizes 10" through 18" use Anvil Fig. #66 in the “U” position.

2.6 SLEEVES AND ESCUTCHEONS

A. Generally where pipes pass through interior building walls or floors above the first floor (out of the ground), 22 gauge galvanized sheet metal sleeves shall be used. Sleeves shall extend a minimum one inch (1") above a floor or beyond the wall, as applicable.

B. All pipes penetrating grade beams, exterior walls, concrete structural members, or concrete slabs of mechanical equipment rooms on the first floor shall generally use standard weight galvanized steel pipe as the sleeving material.

C. For concrete or masonry walls, sleeves shall be inserted into the masonry, decking or form work prior to the pouring or placement of concrete or masonry units to create a leave out.

D. The sizes of all sleeves shall be such as to permit the subsequent insertion of the intended pipe of the proper size with adequate clearance for movement due to expansion and contraction. In the case of insulated lines, the diameter of the sleeves shall be at least 1/2" greater than the outside walls of the pipe with specified thickness of insulation. This will require that the inside diameter of galvanized steel pipe sleeves be at least 1/2" greater than the outside diameter of the service pipe with insulation. Galvanized steel pipe sleeves set in floors shall project two inches (2") above the floor.

E. After the pipes are installed, fill the annular space between the pipe, and insulation as required, and its sleeve with an approved mastic or caulk. Use loose fibrous insulation packing as required to accomplish this. In all cases the annular spaces around the pipes within the sleeved openings shall be filled with loose fibrous insulation and then sealed with an approved caulking or expanded foam insulation.

F. Escutcheons, except as specifically noted or specified, shall be installed on all pipes passing exposed through floors, walls, or ceilings. Escutcheons shall be equal to the Crane No. 10, chrome plated sectional floor and ceiling plates, and shall fit snugly and neatly around pipe or pipe insulation or insulated lines. Solid chrome plates with set screws shall be used if sectional plates do not fit properly or stay in place. Where multiple pipes penetrate floors or walls in close proximity in concealed areas, shop made sheet metal escutcheons may be used.

G. Pipes sleeved through grade beams open to basements, crawl spaces or void spaces below grade shall additionally receive "Link Seal" or equal closures made of interlocking synthetic rubber links. Seals shall provide for absolute water tightness. Seal shall be constructed to insulate electrically pipe from wall. Install as recommended by manufacturer. Provide Century-Line sleeves with water stop and anchor collar for pipes penetrating grade beams designated to be anchored.

H. Where PVC pipes, 3 inches and smaller, and small copper water piping under 2 inches in size, penetrated a horizontal floor slab a metal sleeve will not be required. For these piping systems, completely wrap the piping with a polyethylene tape, or wrapping. This tape shall be minimum 4 mils thick and shall be wrapped at least two times around the pipe and secured sufficiently to hold the wrap in place during the pouring of the slab. This wrap shall be in sufficient length or height to insure that no concrete will be in contact with the pipe. All other piping shall be sleeved as indicated elsewhere herein.

I. Refer to Section 22 05 00 for additional requirements of penetrations through fire-rated assemblies.

2.7 ACCESS DOORS

A. Wherever access is required above inaccessible ceilings, in walls, furrings, chases or soffits to physically reach concealed piping, or equipment installed under Division 22, provide access doors of sufficient size to maintain, repair, replace or suitably access devices intended to be adjusted as indicated herein.

B. Provide an access door or panel for each of any valves, group of valves, damper pull rods, splitter dampers, manual volume dampers, actuators or other controlling mechanism installed under Division 22 which would otherwise be concealed in the building construction with no access.

C. All access doors in toilet rooms, locker rooms, showers, kitchens, or other similar wet areas shall be the flush mounted type and be made of brush or satin finish stainless steel as manufactured by Milcor or ELMDOR.

D. All access doors shall be minimum 18" x 18", unless noted otherwise, in size unless otherwise approved in writing in advance by the Engineer. Doors shall be increased in size as required to allow for a person to reasonably access, adjust, maintain, service, inspect or replace the largest single component concealed. Provide special sizes of access doors as required.

E. Coordinate the final location of all concealed equipment and devices requiring access with the final location of the required access panels or doors. Allow ample space for the removal of all parts and equipment that require replacement or servicing.

F. Where mounting heights are not detailed or dimensioned, install mechanical piping and overhead equipment to provide the maximum headroom possible while maintaining reasonable access and service to those items being accessed.

G. All serviceable equipment shall be within immediate reach (maximum of 12") from the access door.

H. Install all access doors in locations to suit the intended purpose but have each location reviewed and approved by the Architect. In no case shall access doors be located such that the intended purpose is rendered useless.

I. Access doors shall all have spring concealed hinges, screwdriver operated cam latches, be the flush mounted type, open up to, but not more than, 175 degrees, be made of steel, or stainless steel to suit the application, be fire rated (U.L. rated) to match the rating of the surface where the door is placed, and have a powder coated electrostatic primer paint on all steel doors. Furnish the following access door types as described below:

1. Milcor Style DW - Flush drywall type with frame made of 16 gauge steel, panel door made of 14 gauge steel, galvanized steel drywall bead on frame, and removable hinge pins for removal of panel door. Provide minimum of two hinges (12" x 12" and larger) up to 24" x 24" in size and three hinges on access doors above this size. Provide one cam for access doors 14" x 14" and smaller and a minimum of three cams on larger sizes.
2. Milcor Style K - Flush plaster wall or ceiling type made similar to Style DW except with a 22 gauge expansion casing bead, one hinge on 12" x 12" access doors, two hinges on larger doors with either side no larger than 24", three hinges on doors with any dimension of 24" or larger, minimum one cam on doors with no dimension larger than 18" and two or more cams on larger access doors.
3. Milcor Style M or MS - Flush drywall, masonry or tile type made similar to Style DW except with 14 gauge steel frame and doors (16 gauge when made of stainless steel-satin finish), one hinge on access doors up to 18" x 18" in size, two hinges on sizes 20" x 24" and 22" x 22", three or more hinges on sizes 24" x 24" and larger, and the number of cams as standard with the manufacturer.
4. Provide other types of access doors suitable for the application to include surface mount, double leaf for access doors exceeding 36" in any dimension, louvered where indicated on the Drawings, fire rated, recessed or security/detention types as required and compatible with the surface penetrated.

2.8 STRAINERS

A. Strainers shall be of the FDA approved, heat fused epoxy coated (interior and exterior) "Y" pattern type bodies, unless shown or specified otherwise. Body ends shall be screwed or flanged to match the type of joints in the piping in which the strainers are installed. Strainers shall have a 200 psi non-shock, ANSI B16.1 pressure rating. Watts 77F-DI-FDA-125, or Engineer approved equal.

B. Each strainer, screen, or mesh shall be of Type 304 Stainless steel, brass, or monel construction. Screen or mesh sizes shall be as scheduled below:

Pipe Size	Screen/Mesh Size
1/2" - 2"	20 Mesh
2-1/2" - 3"	0.045 Perforations
4" - 12"	0.125 Perforations

C. Where vertical space does not permit the installation of the "Y" strainer, install an equivalent basket strainer.

D. Strainers shall be of the FDA approved, heat fused epoxy coated (interior and exterior) “Y” pattern type bodies, unless shown or specified otherwise. Body ends shall be screwed or flanged to match the type joints in the piping in which the strainers are installed. Strainers shall have a 200 psi non-shock. ANSI B16.1 pressure rating. Watts 77F-DI-FDA-125, or Engineer approved equal.

E. Lead Free Bronze Strainers for screwed piping shall be Watts LF777 Series (cast bronze body) with bronze plug stainless steel mesh strainer for copper piping; piping shall be Watts CI-125 or F-125 and CI-250 or F-250 (cast iron bodies). Equivalent as manufactured by the following will be considered:

1. Nibco.
2. Hammond.
3. Apollo.
4. Milwaukee.

2.9 GAUGES AND GAUGE COCKS OR NEEDLE VALVES

A. Provide the following pressure gauge cock or needle valve connections:

1. At the suction and discharge of each pump.
2. At the domestic water riser, downstream of main isolation value.
3. Downstream of the building main backflow preventor.
4. At the inlet and outlet of pressure reducing stations.
5. At circuit setter balance stations and any other points indicated or detailed on diagrams on the Drawings.
6. At the inlet and outlet of circulation pumps.

B. Where gauge connections are installed in insulated lines, install gauge cocks or needle valves on a nipple of sufficient length that the gauge cock or needle valve handle will be free of the pipe insulation. Position each gauge cock in relation to surrounding piping and equipment so that the gauge may be easily read and so that a gauge having a 4" diameter dial can be screwed into and out of the piping nipple where the gauge cock or needle valve is installed. All gauge cocks shall be of the tee-handle type. Needle valves shall be a Weksler AV32, AV34, or BBV4.

C. Install gauge cocks or needle valves at pumps at the pump suction and discharge flange connections at the pre-drilled and tapped gauge connections as provided by pump manufacturer.

D. Furnish and install a pressure gauge suitably calibrated at each of the following locations:

1. At the suction and discharge of each pump.
2. At the domestic water riser, downstream of main isolation value.
3. Downstream of the building main backflow preventor.
4. At the inlet and outlet of pressure reducing stations.
5. At circuit setter balance stations and any other points indicated or detailed on diagrams on the Drawings.
6. At the inlet and outlet of circulation pumps.

E. Gauges shall be of the bourdon tube type, glycerin filled, and shall be selected to operate at about the midpoint of their full range, i.e., for a 50 PSI operation, select a gauge of 0 to 100 psi. Each gauge shall be provided with a brass lever handle union cock or brass handle needle valve. Cases shall be Stainless Steel, not less than four inches (4") in diameter.

F. Pressure gauges shall be equal to Weksler Model 401L-4-PD with type ASD case, phosphor bronze with phosphor bronze brushed rotary movement and link; 4" dial, nickel plated ring, free standing stainless steel case; equipped with micrometer adjustment pointer. Provide each gauge with scale range suitable for the duty.

G. Provide pulsation dampeners, adjustable snubbers, or piston type pressure snubbers in line with all pump gauges.

H. Cocks and gauges shall be manufactured by:

1. Crosby.
2. Weksler.
3. Marsh.
4. Trerice.
5. Miljoco.
6. Weiss.

2.10 THERMOMETERS AND THERMOMETER WELLS

A. Furnish and install brass or stainless steel closed separable thermometer wells for all thermometer and controller bulbs which are designed for liquid measurements. Whenever a thermometer or controller bulb is inserted in a pipe for either remote or local temperature indication or control, locate the thermometer well so that it will be completely surrounded by flowing fluid. Such thermometer locations as are shown on the Drawings are diagrammatic only. Install thermometer wells for maximum effectiveness and in the case of locally indicating instruments, for easy readability.

B. Supply each brass test well for use with the stem thermometers, a threaded brass plug and keeper chain. Install these test wells in the following locations such that they can be filled with oil to facilitate temperature measurements:

1. At the inlet and outlet of each water coil.
2. At the inlet and outlet of each heat exchanger, evaporator and condenser.
3. At the discharge of each modulating 3-way control valve.
4. At other locations as specified herein or shown on the Drawings.

C. Where thermometer wells are called for, furnish and install brass wells with the tip of the well extending into the water stream. The well shall have a plug attached to it with a short length of chain. The wells shall be installed in the vertical or at 45 degree angle up.

D. Thermometers shall be of the industrial type with red spirit filled liquid (no mercury allowed), bronze enameled aluminum cases, glass fronts, 9" scales, separable sockets; straight or angle pattern so selected that they can be read from the floor. Straight type equal to Weksler Type 105 and angle type equal to Weksler Type 115, Type 125, or Type 135, depending upon the angle and aspect. Furnish thermometers with 2-1/2" stem extensions where they are installed in insulated lines. Select scale ranges for maximum readability at the design temperature of the medium being measured.

E. Thermometers shall be installed in the following locations:

1. At the discharge of each pump or Blending Station valve.
2. At the inlet and outlet of each heat exchanger, evaporator and condenser.
3. At other locations as specified herein or shown on the Drawings.

F. In lieu of the industrial stem type thermometers 5" dial silicon filled bi-metal thermometers with vari-angle feature or “solar only” self-powered digital thermometers (no batteries allowed) with sealed sensor technology, minimum 1/ 2" tall LCD digit size display, 1% accuracy, and variable angle stem assembly shall be allowed.

G. Thermometers and thermometer wells shall be as manufactured by:

1. Weksler.
2. Trerice.
3. Marsh.
4. Taylor.
5. Miljoco.
6. Weiss.

2.11 TEMPERATURE AND PRESSURE TEST PORTS

A. Temperature and Pressure Test Ports, or Pete’s plugs, shall be dual valve type with valve pocket between valves, retaining cap with gasket and cap "saver" connector.

B. These ports may be used at water coil connections in lieu of gauge cocks or needle valves and thermometer test wells.

C. Pete’s plugs shall have the pipe nipple extended to beyond the insulation thickness to make the plug fully accessible and a minimum of one inch (1") above the pipe insulation.

D. Ports shall be as manufactured by:

1. Pete.
2. Autoflow.
3. Flowset.

2.12 RELIEF VALVES

A. All closed water systems shall be protected with a relief valve. Valves shall be spring operated, all brass, and shall meet A.S.M.E. requirements for discharge capacities. Discharge lines shall be piped to the nearest floor drain.

B. Relief valves shall be as manufactured by Watts, Klipfel, McAlear, or McDonnell and Miller.

C. Provide atmospheric relief piping routed to the outdoors as required by local code for all steam and natural gas systems.

2.13 VACUUM RELIEF VALVE

A. All bottom feed domestic water heating equipment shall be protected by a vacuum relief installed on the cold water inlet pipe. Valve shall be compliant with ANSI Z21.22.

B. Product equal to Watts N36-M1.

PART 3 - EXECUTION

3.1 PIPING - GENERAL

A. Where special classes of piping are involved and are not listed, the Contractor shall request instructions from the Owner's Representative as to the class of material involved and the method of fabricating it before ordering any material. All steel lines 2-1/2" and larger shall be assembled by welding. All steel lines 2" and smaller may be assembled either by welding or by screwed fittings as specified.

B. Welding shall be done by mechanics who satisfy qualification requirements of the American Welding Society. The pipe ends to be welded shall be machine beveled wherever possible. Gas cuts shall be true and free from all burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no metal shall project within the pipe. Fully ream, to the full inside pipe diameter dimensions, the inside of all piping to be welded. Miter joints will not be allowed in any case. All headers, connections, elbows, reducers, flanges, and special flanges and special fittings shall be made using forged steel welding fittings of the same weight as the pipe to which they are attached. All unions and connections to valves 2-1/2" and larger shall be made by the use of welded flanges.

C. Branches in lines where the branch side is equal to 2/3 of the size of the main or smaller may be connected by using Weldolets or Threadolets; where the sizes are greater than 2/3 of the main, standard weight seamless tees as manufactured by Tube-Turns or Grinnell, A.S.T.M. Standard A-234 shall be used.

D. The location, direction, and size of all lines are generally indicated on the drawings. Branch connections in general are indicated and shall be so installed as to provide proper grades.

E. All lines shall be made up straight and true at proper grades. All water filled and condensate drain lines shall grade down to drains.

F. Piping shall follow as closely as possible the routes shown on the plans and take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

G. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.

H. All headers shall be assembled as indicated using welding fittings throughout.

I. All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with graphite and oil applied to the pipe threads only and not to the fittings.

J. Dielectric couplings shall be installed where ferrous pipe joins copper lines and shall be rated for the intended medium pressure and temperature or service.

K. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of systems. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items or coils, machinery items and other special pieces of apparatus. Unions in 2" and smaller lines shall be ground joint and unions 2-1/2" and larger shall be flanged unions. Unions shall be the same material and strength as other fittings in the lines. Companion flanges on lines at various items of equipment, machines, and pieces of apparatus shall serve as unions to permit removal of the particular item.

L. All piping shall be supported by hangers independently of equipment connections. The weight of the piping and it's contents shall not be imposed on the equipment in any way.

M. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

N. Swing joints or expansion loops shall be provided wherever shown on the Drawings or wherever else necessary to allow for the expansion and contraction of piping. This shall be accomplished in an approved manner and this Contractor shall be responsible for any damage which may occur as a result of expansion and contraction of his piping.

O. Nipples shall be of the same size and material as the piping in the system in which the nipples are installed, except that "close", or "all thread" nipples shall not be used.

P. Keep all open ends of piping in each system plugged or capped to prevent dirt or other debris from entering the pipe at any and all times during construction and before fixtures or equipment is connected. All piping shall be flushed clear prior to connection to the central building systems.

Q. The ends of all piping furnished and installed in all systems shall be thoroughly reamed to the full inside diameter of the respective pipe.

R. Exposed and concealed lines shall be run parallel with, and perpendicular to building lines and wherever possible shall be grouped together for easy service and identification. Whenever possible, horizontal and vertical runs shall be held as close as possible to the walls, ceilings, struts, members, etc., so as to occupy the minimum space consistent with the proper installation requirements for insulation, conduit, ductwork, lighting fixtures, etc., and the expansion requirements of each of these items and the building proper or the removal of the respective or adjacent pipes, conduits, and ductwork, and to allow for necessary access to valves, other pipes, conduits, dampers, etc.

S. Valves required for control or isolation of any part of the various systems shall be provided and shall be located in approved or accessible positions or made accessible through removable panels, etc., and where several valves are related as to function, they shall be grouped in a battery. Request approval from Owner's Representative for proper location of all access panels required for valves, etc.

T. All automatic control valves shall be installed such that the valve stem is pointed upwards, vertical, and in no case shall it be mounted at less than a 45 degree angle from the vertical position unless specifically approved by the Engineer prior to installation.

U. All shut-off and isolation valves shall generally be installed with valve stems pointed vertically upwards. In no case shall valve stems be pointed downwards or less than in a horizontal position.

V. Where new lines are indicated to connect into existing lines, careful coordination shall be exercised to determine exact elevations and locations of existing lines, to establish grades of interconnecting new lines, to establish procedures to interconnect lines, and to establish other details.

3.2 CROSS CONNECTION AND INTERCONNECTIONS

A. No plumbing fixtures, device, or piping shall be installed which will provide a cross connection or interconnection between a distributing water supply for drinking or domestic purposes and a polluted supply such as drainage system, or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water, or waste into the water supply system.

3.3 EXCAVATION AND BACKFILLING

A. Provide necessary excavating and backfilling for the installation of work specified in this Division as specified in Section 22 05 00 and 31 23 00. Shall comply with ASTM 2321.

3.4 FLASHINGS

A. Flash around all pipes passing through the roof with sheet lead, as specified in Section 07525, built a minimum of 10" into the roofing, in all directions from the outside of the pipe running up the pipe a minimum of 10" and more where vent terminals must be higher to conform to the requirements of the local

Plumbing Code in effect, and then turned over one inch (1") into the pipe cavity. All seams and joints shall be completely soldered closed and the entire flashing shall be completely waterproof.

B. Make all roof penetrations in accordance with the roofing system manufacturers approved methods and as specified in Section 07 52 50.

3.5 PIPE INSULATION INSERTS AND SHIELDS

A. Provide a section of Foamglas insulation, calcium silicate, or urethane of thickness specified at hanger support locations and provide No. 16 gauge galvanized steel protection shield minimum 12" long. Shield shall be full half cylinders equal to Grinnell Fig. 167.

B. Refer to Section 22 07 00, Insulation.

3.6 SAFETY GUARDS

A. Furnish and install all safety guards required in order to obtain certificates of inspection from all authorities having jurisdiction.

B. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

3.7 TESTING AND REPAIRING

A. During the progress of each portion of the work or upon its completion, make such tests of this work as herein specified, or as required by the Architect, or by State or Municipal Bureaus having jurisdiction and under their supervision.

B. Provide all apparatus, temporary piping connections, or any other requirements necessary for such tests. Take all due precautions to prevent damage to the building and its contents incurred by such tests as will be required to repair and make good, at no cost to the Owner, any damage so caused. Testing of piping to be insulated shall be done before insulation is applied.

C. Perform any other tests as may be required by the Owner's Representative to indicate the fulfillment of specification requirements.

D. Pressure piping systems shall be tested with either water or air to a pressure of 150 psig or to 1-1/2 times the operating pressure, whichever is the greatest, for six (6) hours.

E. Domestic hot and cold water piping shall be tested at 1.5 times the operating pressure or 150 PSIG, whichever is greater, for six (6) hours. Any leaks developed shall be made tight and the test repeated. Test pressure shall not be applied to specialties, but joint shall be tested for leaks at operating pressure when complete.

F. Waste and vent piping shall be tested at completion of the rough work and before fixtures and traps are connected. Openings, except tops of bends, are to be plugged and the system completely filled with water. System shall stand without leak or loss of water for a period of not less than four (4) hours.

G. Systems shall be tested in portions as required by the construction schedule and the portions being tested shall be effectively isolated and sealed off. When previously tested sections are connected into other sections, tests shall be rerun to include the new connections.

H. Partial systems shall be tested prior to connecting into existing lines.

I. Leaks in screwed joints shall be repaired by tightening the joint until the leak has stopped, or by remaking the joint if tightening fails to stop the leak. Leaks in welded joints shall be repaired by chipping out the weld around the leak and rewelding until it is stopped. Leaks in caulked joints shall be completely stopped by additional caulking of the joint, but, if that fails, the joint shall be re-made. A leak in a compression joint

shall be repaired by remaking the joint using a new seal, compression ring, coupling, etc., as required. Leaks in soldered joints shall be repaired by remaking the joint and no soldering or brazing over existing joints will be permitted. Any defective piping shall be replaced.

J. Additional testing shall be as specified in the individual Sections of these Specifications.

K. During testing and cleaning of piping systems, use a fine mesh, 20 mesh or smaller, start-up strainer screen for all strainer pipe sizes. After piping system is cleaned each strainer shall be taken apart, cleaned, and final strainer mesh shall be placed back in strainer for normal operating conditions.

3.8 SEALING PENETRATIONS

A. Seal all pipe penetrations through walls run to structure, ceilings, floors and roofs. Fill the annular space between the insulation on the pipe, or the pipe only where uninsulated, and its sleeve, with neoprene or non-hardening sealant.

B. No pipe or duct shall be allowed to contact its surrounding sleeve or the wall, floor, or ceiling. Effective isolation shall be provided as described in Section 23 05 48 to the end that no vibration or direct noise transmission shall be transmitted. Vibration transmission limits shall be as established in Section 23 05 48. Use special materials as may be required to comply.

C. Firestop pipe and duct floor and wall penetrations as specified in Section 07 84 00 and 22 05 00.

3.9 PAINTING

A. All equipment specified in Division 22 shall be delivered to the site with suitable factory finishes as specified elsewhere herein.

B. Items with factory applied finishes shall be protected during installation and other construction work. Damaged factory applied finishes shall be refinished to match the original finish appearance.

C. Field painting of items specified and installed in Division 22 shall be as specified in Section 09 90 00.

D. All ferrous metals that are not galvanized or made of a corrosion resistant alloy shall be painted. This shall include steel pipe hangars, trapeze supports, pipe stands, all thread hangar rods and other miscellaneous systems.

END OF SECTION

SECTION 22 30 00

DOMESTIC WATER HEATING EQUIPMENT AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - General Requirements and referenced documents.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other sections of the specifications, as required.

1.2 SYSTEM DESCRIPTION

A. Provide a complete and operational system of Domestic Water Heating Equipment and Accessories as indicated herein and as indicated on the Drawings.

B. Completely coordinate specified herein work of all other sections of these specifications.

C. Furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a complete and satisfactory operating installation, whether such work is specifically indicated or not.

1.3 QUALITY ASSURANCE

A. Factory Testing: Subject each tank to a factory hydrostatic test pressure of 150 percent of the expected maximum system working pressure and certify that components are free of leaks prior to shipment to the project site. Tank shall have a minimum pressure rating of 150 psig.

B. Manufacturing Standard: Tank shall comply with the ASME Pressure Vessel Code, Section IV.

C. Each water heater (and/or heat exchanger and storage tank) shall have a written unconditional one (1) year cost free service policy, and a written full three (3) year parts and labor warranty against tank failure due to rust, corrosion, or electrolytic action.

D. Each heater shall be UL Listed and Labeled.

E. Each water heater tank shall have fiberglass insulation to meet ASHRAE Standard 90-1b for heat loss and protected by epoxy coated metal jacket.

1.4 SUBMITTALS

A. Project Data:

1. Operating and Maintenance Data, three (3) copies.
2. Furnish factory obtained State Inspection Report and Stamp.
3. Manufacturer's approved Startup Report completed by factory trained and authorized technicians to be furnished to Engineer.
4. Written Equipment Warranties, complete and filled out.

B. Product Data:

1. Electric Storage Water Heaters.
2. Thermal Expansion Tanks.
3. Circulating Pumps, Aquastat and programmable timer.
4. Thermostatic Mixing Valves.

PART 2 - PRODUCTS

2.1 ELECTRIC STORAGE TYPE WATER HEATERS (6 GALLONS THROUGH 119 GALLONS)

A. Provide in each location shown on the Drawings, a glass-lined electric storage type water heater of the size and capacity indicated. Heating elements shall be suitable for electrical current having the characteristics indicated on the drawings. Each heater shall be U.L. Listed and Labeled.

B. Provide factory installed with dial thermostat, high temperature cut-off switch and high temperature and pressure relief valve. Valve shall be of the size and type to meet ASME standards for discharge capacity. Pipe relief valve full size to an approve drain.

C. Tank shall be glass lined internally with alkaline borosilicate composite fused to steel by heating to 1600 Deg.F. Tank shall be furnished with a magnesium anode for corrosion protection.

D. All tanks shall be insulated to meet ASHRAE 90.1b for standby heat loss.

E. Each tank shall be equipped with necessary operating controls.

F. Acceptable manufactures:

1. A.O. Smith
2. Lochinvar

2.2 EXPANSION TANKS

A. Furnish and install a steel pressure vessel furnished with either a stainless steel or galvanized steel head. The pressure vessel shall be designed and constructed per ASME Section VIII, Division 1, with a maximum allowable working pressure equal to or greater than the water heater but no less than 125 psig. Tank shall be equipped with FDA approved heavy duty butyl rubber bladder or diaphragm removable for inspection to provide permanent separation between the air and expanded fluid. The air in the tank shall be contained on the shell side with all expanded fluids being directed in to the bladder or diaphragm chamber. Entire unit shall be FDA approved for potable water systems.

B. Expansion tanks serving water heaters with storage greater than 119 gallons and or with heat input of more than 200,000 BTU shall be ASME rated as required by the State Boiler Code.

C. Provide a brass dielectric union where the expansion tank connected to the potable water system

D. Thermal expansion tank sizing shall be as scheduled on the drawings and be per the manufacturer's recommendation:

E. Provide thermal expansion tanks for each domestic water system where a check valve, or other backflow prevention devices, are installed on the cold water supply to the water heating equipment. Tanks shall be NSF or FDA approved.

F. Acceptable manufacturers:

1. Bell and Gossett "PT" series.
2. Watts "DET" Series.
3. Amtrol “Therm-X-Trol”, or approved equals only.

2.3 HOT WATER CIRCULATING PUMPS

A. Provide centrifugal type in-line circulating pumps with associated controls to circulate the hot water in domestic hot water systems where indicated on the Drawings.

B. Each pump shall be Inline Boosters non-metallic impeller and lead-free stainless steel body, designed for installation in open systems.

C. Furnish an Allen Bradley Bulletin 600 manual starter with thermal overload protection for the control of each pump motor and aquastat with adjustable set point for thermostatic control of pump.

D. Furnish with each pump two ball type isolation valves, discharge check valve, thermometer and aquastat. Provide gauge taps and cocks at inlet and outlet of each pump for testing.

E. Furnish each pump with an automatic timer switch capable of being set to turn off circulation pump. Provide fully automated seven-day programmable timer switch equal to Tork E100 Series, unless recirculating pumps are required to be controlled by the Building Management System.

F. The Aquastat shall be set at a temperature differential of -5 Deg. F. The return loop temperature shall be set to 5 degrees below the supply loop temperature. Shall be equal to Honeywell L4006A

G. Capacities of each pump shall be as scheduled on the Drawings.

H. Acceptable Manufacturers:

1. Grundfos
2. Bell and Gossett
3. TACO.
4. Armstrong.

2.4 THERMOSTATIC MIXING VALVE

A. TM-1: Leonard Model 270-LF, thermostatic point of use mixing valve shall be allowed for single fixture use only and shall be ASSE 1016 listed. Valve shall be bronze body, stainless steel dire and spring, adjustable with locking feature. Copper thermostat assembly. Provide straight check stops, IPS connection. Equal by RADA-215D or Powers KM-495.

B. TM-2: RADA 425-R, 1" inlet, 1" outlets (IPS) Thermostat Mixing Valves with polyeuthetic bimetal coil thermostat directly linked to valve porting, adjustable limit stop, color coded scale: Hot to Cold, wall support, inlet union angle strainer check stops, outlet volume control/shutoff, Inlet piping manifold with unions. Factory modified for top outlet, assembled and tested unit mounted exposed on wall. Mixing valve assembly shall be piped per manufacturer's recommendations. Coordinate with Architect for exact location. Armstrong Intl., RADA valve only, no exceptions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water heaters in accordance with manufacturer's recommendations. Install the relief valves so that the bulbs will be immersed in the tanks. Pipe relief valve outlet full size to the nearest floor drain, hub drain, or outside as required by Governing Authorities and Codes.

B. Coordinate with other trades to provide equipment housekeeping pads as shown on the drawings and per Section 22 05 00.

C. Coordinate with Structural Engineer for approved wall mounted or suspended platforms to support electric water heaters located above the floor. Submit equipment weights and proposed supports, brackets and platform framing to the Structural Engineer for review and approval prior to purchasing or fabricating platform.

D. Furnish Operations and Maintenance Manuals, and written warranty, for each domestic water heating equipment and accessories as required in Division 01 specifications and Section 22 0500.

E. Provide thermal expansion protection for all heating equipment as specified and required by heating equipment manufacturer's written warranty.

F. All thermostatic mixing valves or other “anti-scalding” devices shall be concealed in walls and fully accessible for service, repair, or replacement through an adequately sized access door panel with a loose key lock.

G. Domestic water heaters in excess of 119 gallons storage and/or heat input in excess of 200,000 BTU/Hr shall be installed to meet all location and clearance requirements as set forth in the Texas State Boiler Law, which includes, but is not limited to; a minimum horizontal clearance of two feet on all sides of the heater and a minimum vertical clearance of four feet from the top of the heater to the bottom of the roof joist or above floor structure.

H. Coordinate with the Electrical Contractor for available voltage, phase and circuit breaker size required for the heater. Electrical requirements shall be verified prior to ordering equipment.

I. Furnish and install heat traps on the supply and discharge piping for all domestic heating water systems not provided with recirculation system and/or water heating equipment with integral heat traps.

J. Furnish and install relief valves on cold water inlet piping for all bottom feed water heaters. Valve shall comply with ANSI Z21.22.

END OF SECTION

SECTION 22 42 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - General Requirements and referenced documents.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other portions of the work.

1.2 SYSTEM DESCRIPTION

A. Provide items of plumbing related equipment and accessories as indicated herein and as illustrated on the Drawings.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 70 00.

B. Indicate on submittal construction materials, finishes, sizes, quantities and related hardware.

C. Product Data:

1. Plumbing fixtures.
2. Carriers.
3. Fixture trim.

D. Certification: Submit certification that completed system complies with test requirements of municipality, State, and other public authorities having jurisdiction over system.

E. Provide closeout documents as required in Division 1, Section 01 70 00.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:

1. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.
2. Provisions specified in this Section.
3. International Plumbing Code.

1.5 HANDLING

A. Deliver fixtures crated and in undamaged condition.

B. Replace damaged fixtures with new fixtures.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. NOTE: The following manufacturers are considered acceptable, however, products submitted in lieu of specified item shall be equivalent to specified item as determined by the Architect and Engineer.

B. Standard Plumbing Fixtures:

1. American Standard.
2. Kohler.
3. Sloan
4. Zurn.
5. Elkay.
6. Just.

C. Carriers:

1. Jay R. Smith.
2. Zurn.
3. Wade.
4. Josam.
5. Watts.

D. Seats:

1. Church.
2. Beneke.
3. Olsonite.
4. Centoco.

E. Faucets:

1. T&S Brass.
2. Sloan
3. Delta

F. Flush Valves:

1. Sloan, Royal, or Zurn, Aqua Vantage AV.
2. Sloan, “Sloan”, or Zurn, Aqua Flush Plus.

G. Lead-Free Stop Valve in Hot and Cold Supply Lines to Each Fixture:

1. Chicago.
2. McGuire.
3. T&S Brass.
4. Engineered Brass Company.

H. Stainless Steel Sinks:

1. Elkay.
2. Just.

I. Service Sinks:

1. Fiat
2. Stern Williams.
3. American Standard.
4. Acorn.

J. Electric Water Coolers:

1. Halsey-Taylor.
2. Oasis.

K. Emergency Fixtures:

1. Bradley.
2. Haws.

2.2 MATERIALS

A. Fittings: Chrome plated heavy cast brass.

B. Nipples: Extra heavy. Provide brass nipples or stainless steel nipples for domestic water systems including nipples at water heater & storage tank connection (no black steel nipples shall be allowed in domestic water systems).

C. Plumbing Fixture Trim: Solid brass, including nuts and washers, handles, hold-down screws, valve bodies, swivel spouts, ferrules, sleeves, locknuts, and bushings.

D. Piping Connections from Shutoff or Stop Valve to Fixture: Chrome plated brass pipe or chrome plated copper tubing.

E. Floor and Wall Escutcheons: Chromium plated with set screws.

F. Exposed Fixture Trimmings and Fittings: Chromium plated brass with polished, bright surfaces.

G. Flush Valves: Non-hold open type, without seat bumpers.

H. Traps: Chrome cast brass adjustable P-traps with cleanout.

2.3 DESIGN AND FABRICATION

A. Plumbing fixture trims shall allow renewable operating units to be removed without detaching supply fitting or faucet.

B. Fixtures, except water closets and urinals, shall have water supply above rim.

C. Equip fixtures with supply discharge below rims with backflow preventers.

D. Furnish angle stops, straight lock shield, loose-key pattern stops for supplies' and install with fixtures. Supplies shall be rigid, unless noted otherwise.

E. Exposed traps and supply pipes for fixtures shall be connected to rough piping systems at wall.

F. All plumbing trim and fixtures indicated on Drawings as handicap shall meet the current requirements of the Americans with Disabilities Act (ADA) and the Texas Accessibility Standards (TAS).

G. Faucets, bubblers, & supply stops shall be National Sanitation Foundation (NSF) Standard 61, Section 9, compliant and listed for residential/drinking water use as required by the Federal Clean Water act effective January 1, 1997 in addition shall be Lead-Free per "Safe Drinking Water Act" U.S. Senate Bill S.3874.

2.4 PLUMBING FIXTURE SCHEDULE

WC-1 - WATER CLOSET - FLOOR MOUNTED BOTTOM OUTLET - FLUSH VALVE:
1. American Standard – 2234.001 "Madera", floor mounted bottom outlet, siphon jet, elongated bowl, 1.28 GPF, vitreous china with 1-1/2 inch top spud.
2. Flush Valve: Sloan "Royal" 111-1.28, 1.28 GPF, polished chrome, externally adjustable, diaphragm type with 1" screwdriver angle stop, metal oscillating handle with sweat solder adaptor kit and cast wall flange with set screw.
3. Seat: Church 94000-SSC (5321.112) solid plastic, white, elongated, open front seat, less cover, combination check and self-sustaining hinges with stainless steel posts.
4. Provide 3" closet bend and wax ring for watertight waste connection.

WC-2 - WATER CLOSET - FLOOR MOUNTED BOTTOM OUTLET - FLUSH VALVE - ADULT HANDICAP:
1. American Standard – 3043.001 "Madera, floor mounted bottom outlet, siphon jet, elongated bowl, 1.28 GPF, vitreous china with 1-1/2 inch top spud. ADA compliant
2. Flush Valve: Sloan "Royal" 111-1.28-YBYC, 1.28 GPF, polished chrome, externally adjustable, diaphragm type with 1" screwdriver angle stop, metal oscillating handle with sweat solder adaptor kit and cast wall flange with set screw.

3. Seat: Church 94000-SSC (5321-112), solid plastic, white, elongated, open front seat, less cover, combination check and self-sustaining hinges with stainless steel posts.
4. Provide 3" closet bend and wax ring for watertight waste connection.

U-1 - URINAL (STANDARD):

1. American Standard “Washbrook” # 6590.001, wall hung, siphon jet with raised dome strainer, vitreous china with 3/4" top spud, flushing rim and 2" female outlet connection.
2. Flush valve: Sloan "Royal" 186-0.5-YBYC, 0.5 GPF, polished chrome, externally adjustable, diaphragm type, with 3/4" screwdriver angle stop, metal oscillating handle with sweat solder adapter kit and cast wall flange with set screw.
3. Support: Josam 17800 Series floor mounted carrier with bearing plate.
4. Mounting height as directed by Architect.

U-2 - URINAL - HANDICAP:

1. American Standard “Washbrook” # 6590.001, wall hung, siphon jet with raised dome strainer, vitreous china with 3/4" top spud, 14-1/2" elongated, flushing rim and 2" female outlet connection.
2. Flush valve: Sloan "Royal" 186-0.5-YBYC, 0.5 GPF, polished chrome, externally adjustable, diaphragm type, with 3/4" screwdriver angle stop, metal oscillating handle with sweat solder adaptor kit and cast wall flange with set screw.
3. Support: Josam 17800 Series floor mounted carrier with bearing plate.
4. Mounting height as directed by Architect.

L-1 - LAVATORY - (WALL HUNG):

1. Same as fixture Type 'L-2' - except provide straight tailpiece in lieu of wheelchair off-set tailpiece and less insulation kit.
2. Mounting height as directed by Architect.

L-2 LAVATORY - WALL HUNG - HOT AND COLD WATER - HANDICAP:

1. American Standard – 0495-221 “Ovalyn”, 17" x 14", oval shaped, unglazed rim for undercounter mount, vitreous china with overflow and clamp. Furnish with mounting kit. ADA/TAS compliant for wheelchair front approach clearances.
2. Faucet/Strainer: Sloan EFX-200-4-BOX-CP-0.5GPM-MM-IR-FCT Sensor Operated Automatic Lavatory Faucet with 5" integral cast brass chrome plated spout, faucet and sensor housing, 0.5 GPM vandalproof aerator, cable, connection box, solenoid valve, and 120VAC to 24 VAC box mount transformer EL-154, built-in check valves and in-line Y-strainer. Provide Chicago 327-XCP perforated grid drain and wheelchair offset tailpiece for ADA front approach access. Unit shall be factory set to operate a minimum of 20 seconds.
3. Supplies: McGuire chrome riser supplies with loose key angle stops and chrome escutcheon plate with set screw.
4. Trap: McGuire 1-1/4" x 1-1/2", 17 gauge, chrome cast brass P-trap with cleanout plug and chrome escutcheon plate with set screw.
5. Support: Josam 17100 Series floor mounted carrier with concealed arms.
6. Insulate exposed water supplies and drain piping with ADA approved insulation kit, equal to Truebro "Lav-Guard" Kit No. 102 and 105.
7. Mounting height as directed by architect.

EWC-1 - ELECTRIC WATER COOLER - HI/LO – BOTTLE FILLER - WALL HUNG - ADA COMPLIANT

1. Halsey-Taylor HTHB-HAC-G8BLSS-WF, barrier-free, ADA Compliant Bi-Level wall hung electric water cooler with hermetically sealed air cooled condensing unit, self-closing anti-squirt flexi-guard bubbler volume regulator with front and side push-bars and with bottle filler and filter. Cooler shall deliver 8.0 GPH of 50 Deg.F. water at 90 Deg.F. ambient and 80 Deg.F. inlet water. Provide all stainless steel finish, unless designated otherwise by Architect. Furnish accessory apron when units are mounted on an exposed wall or necessary to provide the ADA mandatory underside clearance. Provide Owner with 12 pack filter replacement, 55898C-12PK.
2. Support: Josam 17900 Series floor mounted carrier.
3. Supplies: McGuire chrome riser supply with wheel handle stop and chrome escutcheon plate with set screw.

4. Trap: McGuire 1-1/4" x 1-1/2", 17 gauge, chrome cast brass P-trap with cleanout plug and chrome escutcheon plate with set screw.
5. Mounting height as directed by Architect.

DF-1 - NON-FREEZE DRINKING FOUNTAIN – BI-LEVEL WITH BOTTLE FILLER

1. Most Dependable Fountain 10485-WM drinking fountain with stainless steel panel with freeze resistant boxes, Elkay LKFRB1. Furnish accessory apron when units are mounted on an exposed wall as necessary to provide TAS mandated maximum floor to underside clearance. Provide stainless steel access panel on backside of unit at the freeze resistant box.
2. Support: Provide Most Dependable Fountain wall carrier plate shall be installed as required by manufacturer and anchored through interior CMU.
3. Supplies: McGuire chrome riser supply with loose-key stop and chrome escutcheon plate with set screw.
4. Trap: McGuire 1-1/4" x 1-1/2", 17 gauge, chrome cast brass P-Trap with cleanout plug and chrome escutcheon plate with set screw.
5. Mounting height as directed by Architect.

S-1 - LOUNGE/BREAK ROOM SINGLE COMPARTMENT SINK WITH DISPOSER, HANDICAP -

1. Sink: Elkay ELUHAD2115, single compartment, Type 302, 18 gauge stainless steel, 21" x 15-3/4" x 4-3/8" deep, undermount sound deadened underside, with mounting brackets. 3-1/2" drain opening, off-set front-to-back ADA Compliant.
2. Faucet: Delta “Trinsic” 9159-DST , bottom mount, cast brass valve body, rigid copper, center set, gooseneck swing spout will pull-down sprayer, ceramic single lever handle, vandal-resistant, ADA compliant, with vandalproof aerator.
3. Tailpiece and Strainer: McGuire #151A stainless steel strainer drain with conical strainer basket and neoprene stopper, 1-1/2" o.d. off-set wheelchair chrome plated brass tailpiece.
4. Trap: McGuire 1-1/2" x 1-1/2", 17 gauge, chrome cast brass P-trap with cleanout plug, and chrome escutcheon plate with set screw.
5. Insulate exposed water supplies and drain piping with ADA approved insulation kit, equal to Truebro "Lav-Guard" Kit No. 102 and 105.
6. Provide In-Sink-Erator No. Badger 1, 1/3 horsepower, 120 volt, single phase disposal

S-2 - LOUNGE/BREAK ROOM DOUBLE COMPARTMENT SINK WITH DISPOSER, HANDICAP -

1. Sink: Elkay ELUHAD3216, 33 inch by 21-1/4 inch by 4-3/8” deep, double compartment, undermount, 18 gauge Type 302 stainless steel sink with underside undercoated. 31/2” drain opening off-center front-to-back, ADA compliant.
2. Faucet: Delta “Trinsic” 9159-DST , bottom mount, cast brass valve body, rigid copper, center set, gooseneck swing spout will pull-down sprayer, ceramic single lever handle, vandal-resistant, ADA compliant, with vandalproof aerator.
3. Tailpiece and Strainer: Elkay LK-35 chrome plated brass strainer drain, 1-1/2" o.d. chrome plated brass tailpiece with conical strainer basket and neoprene stopper.
4. Continuous Waste: McGuire 1-1/2", 17 gauge chrome plated brass tubing for double compartment sink with disposer.
5. Trap: McGuire 1-1/2" x 1-1/2", 17 gauge, adjustable, chrome plated, cast brass P-trap with cleanout plug and chrome escutcheon plate with set screw with connection for disposer.
6. Supplies: McGuire chrome riser supplies with wheel handle angle stops with chrome escutcheon plate with set screw.
7. Provide In-Sink-Erator, “Badger 1", 1/3 horsepower, 120 volt, single phase disposal and power cord kit

S-3 - SINK (FREE STANDING):

1. Elkay Model SS-8124 "Sturdibilt" 27" x 27-1/2" with 8" backsplash, single compartment 24" x 24" x 14" deep, construction, #14 gauge nickel bearing stainless steel. Type 304, square corner welded construction. Welds cleanably smooth. Sink polished to an Lk-5K satin finish. Channel rims, straight line styling. Drain board and sink compartment pitched to drain. Sink supported on (4) LK-251 stainless steel tubular legs, 1-5/8" O.D., with adjustable bullet shaped feet. Unit drilled for standard faucet and drain outlets.

2. Faucet: T& S Brass B-0231--CR 8" Wall Mount Mixing Faucet w/ 1/4 Turn Ceramic cartridges, Lever Handles, 6" Cast Spout & 1/2" NPT Female Inlets
3. Strainer: Elkay No. LK-24-RT waste fitting with lever handle.
4. Trap: McGuire 1-1/2" x 1-1/2", 17 gauge, chrome cast brass P-Trap with cleanout plug and chrome escutcheon plate with set screw.
5. Supplies: McGuire chrome riser supplies with loose key angle stops and chrome escutcheon plate with set screw.
6. Solids Interceptor: Josam 61030 cast aluminum, top access, fixture trap type, one and one-half inch (1-1/2") threaded connections, basketed sediment bucket and removable stainless steel screen and acid-resisting interior finish.

S-4 SINK – DISCOVERY LAB – PREP ROOM (HOT AND COLD WATER) WITH DISHWASHER - HANDICAP

1. Sink shall be intricate part of the countertop.
2. Contractor shall furnish all trim, supplies, and labor necessary to make final connection to fixtures furnished by others.
3. Coordinate with others for proper supplies to match faucet furnished by others.
4. Provide McGuire chrome supplies with angle stops, Just J-35-GS-316 crumb cup strainer and offset tailpiece. Furnish and install acid resistant 1-1/2" x 1-1/2" P-trap and arm.
5. Solids Interceptor: Josam 61030 cast aluminum, top access, fixture trap type, one and one-half inch (1-1/2") threaded connections, basketed sediment bucket and removable stainless steel screen and acid-resisting interior finish.

S-5 SINK - DISCOVERY LAB – TEACHER (HOT AND COLD WATER)) - HANDICAP

1. Same as sink ‘S-4’ except less dishwasher connection.

S-6 - DISCOVERY LAB – STUDENT (TEMPERED WATER ONLY) – HANDICAP

1. Same as Fixture Type "S-5" except provide single supply riser for tempered water connection to faucet furnished by others.

MS-1 - MOP SINK:

1. Stern Williams “Corlow” SBC-1700 terrazzo 24 inch by 24 inch floor mounted basin with 12 inch high walls with 302 stainless steel cap cast integral on threshold. Drain shall be cast brass drain body with stainless steel strainer, flat head, and slotted machine screws included.
2. Faucet: T&S Brass B-0665-BSTP-CR chrome plated, integral check stops, vacuum breaker, wall bracket pail hook, 3/4 inch hose thread, and 8 inch center with quarter turn ceramic cartridge handles.
3. 5'-0" Hose with Hose Bracket: Stern-Williams T35.
4. Splash Catcher Panel of 20 Gauge, 304 Stainless Steel: Stern Williams BP.
5. Important: Float basin with wet mortar between slab and basin to distribute weight evenly and prevent cracking of basin. Refer to installation recommendations by manufacturer.

SS-1 - SERVICE SINK:

1. Stern Williams “SERVICEPTOR” SB-650 terrazzo 32 inch by 32 inch floor mounted basin with 12 inch high walls with 302 stainless steel cap cast integral on threshold. Drain shall be cast brass drain body with stainless steel strainer, flat head, and slotted machine screws included.
2. Splash Catcher Panel of 20 Gauge, 304 Stainless Steel: Stern Williams BP.
3. Important: Float basin with wet mortar between slab and basin to distribute weight evenly and prevent cracking of basin. Refer to installation recommendations by manufacturer.

SH-1 – HAND HELD SHOWER – HANDICAP:

1. Shower: Leonard PAM -II-ST "Pressure Activated Mixer", 1/2" inlets, 1/2" outlet, concealed piping, bronze and stainless steel construction, control valve shall be adjustable high temperature limit stop, with built-in shut-off, color coded dial indicator, wall flange, exposed parts stainless steel or chrome plated, with angle check stops and copper tube connection.
2. Hand Held Shower Head: Leonard 62001 fixed spray hand shower, 24" chrome plated wall bar with adjustable mounting flange and adjustable height slide bracket, chrome plated brass swivel connector, 69" chrome hose with quick disconnect, chrome plated supply elbow with flange and inline vacuum breaker, flow rate 2.5 GPM.

3. Factory installed check valves on both the hot and cold water supplies. The mixing valve shall be factory pre-set for 120 Deg.F. maximum temperature. Contractor shall adjust temperature setting to deliver a max. of 110 Deg. F.
4. All shower controls and heads shall be located per Architectural Drawings, and shall comply with ADA mounting height requirements. All piping in wall and shower head shall be rigidly secured.

ICB-1 - ICEMAKER BOX CONNECTION

1. Guy Gray Model BIM-875-QTS, 20 gauge stainless steel box, hot dipped galvanized, and ½" quarter turn angle valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's printed instructions and drawings.

B. Fasten fixtures secured to masonry walls or stud partitions with 1/4" brass toggle or through-bolts.

C. Anchor inserts flush with finished wall and conceal when fixtures are mounted.

D. Fixture Connections:

1. Make connections between earthenware fixtures and flanges on soil pipe gas tight and watertight with closet-setting compound or with neoprene gasket and seal.
2. Do not use natural rubber gaskets or putty for these connections.
3. Bolts shall be not less than 1/4" diameter and shall be equipped with chromium plated nuts and washers.
4. Set fixtures with outlet flanges required distance from floor or wall to make first class joint with gasket and fixture used.

E. Refer to Architectural Drawings for all mounting heights and exact locations. Coordinate with General Contractor prior to starting any work, provide any additional supports, hangers, openings, etc. as required for a complete installation. Coordinate all clearances and locations with other trades as required.

F. Provide stop valve in each hot and cold water supply line to each fixture.

3.2 MILLWORK AND CASEWORK FIXTURES

A. Furnish and install all sinks and other plumbing items shown on furniture, unless shown otherwise. Provide detailed information to the supplier of such furniture as to required cut-outs and drillings, so as to permit proper coordination during fabrication. Provide local shut-off valves in all supplied to such furniture. Provide all waste connections, including drains, p-traps and other materials, using sanitary materials corresponding to piping system material in each case.

3.3 FIXTURES FURNISHED UNDER THIS DIVISION

A. Plumbing fixtures and equipment shall be set in place, leveled and connected as indicated on the drawings. Use china caps to conceal mounting bolts, and grout between all vitreous china fixtures and finished wall and floor surfaces with plaster of paris or portland cement.

B. Install wall hung water closets, lavatories, urinals, sinks and electric water coolers on carriers.

C. Do not install metal fittings until adjoining tile work has been acid- cleaned. The Mechanical Contractor shall be responsible for the proper protection of fixtures after installation.

D. Connections to exposed plumbing fixtures shall be complete with chrome plated brass nipples, tubing, wall escutcheons, etc.

3.4 ADJUSTING AND CLEANING

A. Prior to final acceptance of the work, Mechanical Contractor shall inspect all faucets, flush valves, stop valves, etc., to determine whether they operate properly and discharge proper quantities of water. Connect any deficiencies to satisfaction of Architect's representative.

B. Thoroughly clean all plumbing fixtures, trim and accessories of all tape, adhesives and other foreign materials prior to final acceptance.

END OF SECTION

SECTION 23 00 00

HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The work in this Division covers all HVAC work specified in all Division 23 Specification Sections and as illustrated on the HVAC Drawings. Comply with other Division 23 Specification Sections as applicable. Refer to other Divisions for coordination of work with other trades.

B. Provide all labor, materials, equipment, transportation, tools and services, and perform all operations required for, and reasonably incidental to, the providing of mechanical system work described in this Division.

C. Contractor shall include providing instructions and demonstrations of the operation of each installed system in its totality to the Owner. Refer to Division 23 specifications for specific Owner training requirements. As a minimum include training of the Owner's Operating Personnel on:

1. Safety Shut-Down of HVAC Equipment.
2. Sequence of HVAC Equipment Operation.

D. Operation and Maintenance of all HVAC Equipment.

E. The Conditions of the Contract, including the General Conditions and Supplementary Conditions, and Division 1 - General Requirements, apply to work covered by this section.

F. Refer to Specification Section 01 32 00 for “Construction Progress Documentation”.

1.2 RELATED DOCUMENTATION

A. Section 01 60 00: Product Requirements.

B. Section 01 73 00: Execution and Closeout Requirements.

C. Section 01 78 00: Project Record Documents.

PART 2 - EXECUTION

NOT USED

PART 3 - EXECUTION

3.1 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to Substantial Completion, fully instruct the Owner in the operation, adjustment, and maintenance of products, equipment, and systems; including, but not limited to all HVAC equipment, related accessories and components, temperature controls and the energy management system. Owner shall operate all systems in cooperation with Contractor for a

B. Arrange for services of qualified manufacturer's representatives to fully instruct Owner on specialized portions of installations, such as air handling units and auxiliaries; VAV terminal units, automatic temperature controls, and water treatment systems.

C. Arrange for each installer of equipment that requires regular maintenance to meet with Owner to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by trained manufacturer's representatives. Include detailed review of the following items:

1. Operating and Maintenance Manuals.
2. Record Documents.
3. Spare Parts and Materials.
4. Lubricants.
5. Cleaning.
6. Standard and Extended Warranties.
7. Maintenance Requirements, Agreements, and similar continuing commitments.

D. As a part of these instructions for operating equipment, demonstrate the following procedures:

1. Start-Up.
2. Shut-Down.
3. General System Operating Instructions.
4. Emergency Operating Conditions.
5. Noise and Vibration Adjustments, where applicable.
6. Safety Procedures.
7. Economy and Efficiency Adjustments.
8. Effective Energy Utilization.

E. Return at first change of season for changeover from air conditioning to heating, or from heating to air conditioning, to demonstrate system operation in the opposite season.

F. Submit a complete record of instructions as a part of maintenance instructions and the data book (Operations and Maintenance Manual) given to Owner. For each instructional period, supply the following data:

1. Date of Instruction.
2. System or Equipment Involved.
3. Names of Persons Giving Instructions.
4. Other Persons Present.
5. Time Period (in hours/minutes) Instruction Provided.

G. Amount of time to be devoted to instructional sessions shall be reasonable and consistent with the size and complexity of equipment and systems installed and as specified in other sections of these specifications.

3.2 SCHEDULE OF WORK

A. Reference Division 1 for Additional Scheduling Information.

B. Work under the various specification sections must be expedited and close coordination will be required in executing this work. Various system installers shall perform their portion of the work at such times as directed so as to insure meeting scheduled dates, and to avoid delaying the work of other trades. Owner's Representative will verify scheduled times of work in the various areas involved, each system installer shall cooperate in establishing these times and locations and the system installers shall process their work so as to insure proper execution and completion.

C. Under no conditions shall any work be done in the present building that would interfere with its natural or intended use, unless special permission is granted by the Owner. This is particularly applicable where new connections are to be made to existing lines, services, or items of equipment in the present building or where existing equipment items or services in that building are to be replaced or modified in any way.

D. Generally, modifications to, replacing of, or making new connections into existing service lines shall be accomplished only during the times directed by the Owner. New lines shall be installed and tested before connections are made into existing lines, meters, or services.

E. All other modifications to existing piping systems and appurtenances, including necessary interconnections between old and new portions of the various systems, shall be accomplished at times scheduled so as not to interfere with the normal use of the building and the existing systems to which connection is to be made.

F. The use of any type of fastening or hanging device which requires the use of shots or explosives of any nature shall not be used.

G. Where required by conditions at the site, Contractor shall perform portions of work at night or at other such times as may be required to insure completion of work on schedule. No additional compensation to the Contractor will be paid for such work or required utilities.

H. Contractor shall be available, as deemed necessary for job progress by the Owner, for weekly progress and coordination meetings with the Architect, Engineer, and other Owner's Representatives, when required. These meetings shall be used to monitor progress of submittals, receipt of materials, construction progress, cooperation of trades, field coordination by the Contractor, and to resolve unforeseen conditions in an expeditious manner. Failure to attend meetings, to respond in a timely manner to requests for information, or to progress at an acceptable pace to maintain the construction schedule shall constitute a delay by the Contractor and may be cause for assessment of fees to the Contractor as outlined in Division 1.

I. Provide all temporary connections as necessary to facilitate the phasing of construction, even where not specifically shown. Where temporary work is required it may be required that the Contractor produce a Shop Drawing or field sketch to illustrate the intended methods which shall be submitted for approval by the Architect.

3.3 CLEAN UP

A. Remove all debris, rubbish, and materials resulting from cutting or patching operations from the work area on a daily basis.

B. Where such work generates dust and debris take all precautions necessary to prevent dust and debris from accumulating in or on other mechanical and electrical equipment. This may require adding temporary filter media over ventilation air openings of certain types of equipment.

C. At the conclusion of this work clean all building materials, mechanical equipment and electrical equipment so that all items are dust free and operating properly. Where dust causes damage to equipment the Contractor shall make repairs to this equipment at no cost to the Owner.

D. Transport all demolished materials and equipment indicated above in approved containers and legally dispose of all debris off site in a manner approved by the Architect and Owner.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Conditions of the Contract including the General Conditions, Supplementary Conditions, and Division One, shall apply to work of this Division, whether attached or not.

B. The requirements specified in this Section shall be applicable to work specified in other Sections within this Division.

1.2 SCOPE OF WORK

A. All Division 23 sections of these specifications shall include all labor and material to complete the entire mechanical systems as specified and shown on the Drawings.

B. All work shown and specified shall be completely installed and connected by mechanics properly qualified to perform the work required. All work shall be left in a satisfactory operating condition as determined by the Owner and Owner's Representative.

C. Provide all services and perform all operations required in connection with, or properly incidental to, the construction of complete and fully operating systems with all accessories as herein specified and shown on the Drawings.

D. Refer to "Conditions of Work" in Division 1.

1.3 GENERAL

A. The accompanying Drawings show diagrammatically the sizes and location of the various equipment items and the sizes of the major interconnecting piping and ductwork, without showing exact details as to elevations, offsets, control lines, and other installation details. The Contractor shall carefully lay out his work to conform to the site conditions, to avoid obstructions and provide proper grading of lines. Exact locations of outlets, apparatus, and connections thereto shall be determined by reference to the Drawings, reviewed Shop Drawings, including equipment drawings, and rough-in drawings, by measurements at the building, and in cooperation with work specified in other sections of these specifications. Minor relocations necessitated by the conditions at the site or directed by the Architect shall be made without any additional cost to the Owner.

B. These specifications and the accompanying Drawings are intended to describe and illustrate systems which will not interfere with the structures, which will fit into available spaces, and which will insure complete and satisfactorily operating installations. Contractor shall coordinate the proper fitting of all material and apparatus into the building and shall prepare larger scale installation drawings for all critical areas, areas with limited working clearances, and areas of significant congestion requiring a higher level of coordination illustrating the installation of work specified in Division 23 in relation to all other portions of work specified in other Sections of these Specifications. Interferences with other portions of work, or the building structure, shall be corrected before any work proceeds. Should changes become necessary on account of the failure of the Contractor to comply with these stipulations, Contractor shall make all necessary changes at no expense to the Owner.

C. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted on the Drawings.

D. It is the intent of the Contract Documents to provide an installation complete and operational in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section, or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems and required to complete the installation.

E. Contractor sets forth that all personnel have the necessary technical training and ability; and that all work specified in this Division will be installed to the best standard of each trade, and will be complete and in good working order. If any of the requirements of the Drawings and specifications are impossible to perform, or if the installation when made in accordance with such requirements will not perform satisfactorily, report same to the Architect promptly after discovery of the discrepancy.

F. No extra compensation will be allowed for extra work or changes caused by failure to comply with the above requirements.

1.4 EXAMINATION OF THE SITE

A. Contractor shall visit the site, verify all items indicated on the Drawings or specified, and familiarize himself with the work conditions, hazards, grades, actual formations, soil conditions, points of connection, utility locations, and local requirements.

B. Contractor shall take these conditions into consideration, and the lack of specific information on the Drawings shall not relieve the Contractor of any responsibility.

C. All site visits shall be coordinated and scheduled with the Owner.

1.5 CUTTING AND PATCHING

A. Excessive cutting of the building structure, walls, floors, ceilings, roof, etc., will not be permitted. No structural member shall be notched or cut unless specifically shown on the Drawings, or unless such cutting is authorized by the Architect.

B. Provide for all holes or openings of proper size and shape as may be necessary for the proper installation of work specified in Division 23, consulting with the Architect regarding proper locations and sizes.

C. Where deemed necessary, and after consulting with the Architect, perform all cutting and patching required for the installation of piping, ductwork, etc. This shall include the cutting of concrete floors, concrete and tile floors, walls, ceilings, roofs, etc. It shall also include patching them as required to restore work to match existing finishes, following installation, testing, backfilling, insulation, etc.

D. Holes through concrete shall be drilled with "Mole", "Core-It', or other diamond point hole saw.

1.6 CODE REQUIREMENTS

A. Contractor is required to comply with the requirements of all National, State, and local codes and utility companies having jurisdiction. In no case does this relieve the Contractor of the responsibility of complying with the requirements of these specifications and Drawings where specified conditions are of higher quality than the requirements of the above specified offices. Where requirements of the specifications and Drawings are below the requirements of the above offices having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above offices and shall notify the Architect promptly.

B. Contractor shall comply with the requirements and standards set forth by, but not limited to, the following:

1. (NFPA) National Fire Protection Association.
2. (OSHA) Occupational Safety and Health Administration.
3. (NEC) National Electric Code.
4. (IECC) International Energy Conservation Code.

5. Local Plumbing Code.
6. Local Building Code.
7. Local Mechanical Code.
8. Local Fire Code.
9. Local Energy Code.

C. Contractor shall obtain all permits, inspections, and approvals as required by all authorities having jurisdiction. Fees and costs incidental to these permits, inspections, and approvals must be assumed and paid by the Contractor.

1.7 RECORD DRAWINGS

A. Contractor shall, during the execution of work, maintain a complete set of “Record Drawings” upon which all locations of equipment, ductwork, piping, and all deviations and changes in the work shall be neatly recorded for use in producing "As Builts" at Project Close- Out. This shall include the incorporation of all Supplemental Drawings issued during the Construction Period.

B. All “Record Drawings” shall be reviewed monthly during the Construction Period, along with the monthly Pay Application Request.

C. Refer to Section 01 73 00, Execution and Close-Out Requirements.

1.8 RECORDS AND INSTRUCTIONS FOR OWNER

A. Accumulate during the job's progress the following sets, in triplicate, in accordance with the provisions of Section 01 73 00, Execution and Close-Out Requirements:

1. Warranties and guarantees and manufacturer's directions on equipment and material covered by the Contractor.
2. Equipment and fixture brochures, wiring diagrams, and control diagrams.
3. Copies of reviewed Shop Drawings, and material and equipment submittals. Copies of rejected submittals and Shop Drawings are not to be provided.
4. Operating instructions for heating and cooling and other mechanical systems. Operating instructions shall include recommended maintenance and seasonal change-over procedures.
5. Other data and drawings required during construction.
6. Repair parts lists of all major items and equipment including name, address, and telephone number of local supplier or agent.
7. Valve tag charts and diagrams specified elsewhere herein.
8. "As-Built" Record Drawings shall be provided in electronic format on a USB device (provide two (2) copies) in a PDF or DWG format as determined by the Owner.
9. Provide copies of all City Inspection Certificates of Approval.
10. Provide Contractor's Certification Statement that all equipment furnished and all work performed is in compliance with all applicable codes referenced in these specifications, or those which are currently in effect.

B. Provide not less than two (2) days of operating instructions, during the adjustment and testing period, to the Owner's operating personnel in order to familiarize them with the proper care and operation of all equipment.

C. All of the above data should be submitted to the Architect for approval at such time as the Contractor asks for his last payment request, just prior to his final payment request. In no case will any portion of retainage be released until these documents are submitted and accepted.

D. Refer to related portions of Division 1 for Project Close-Out requirements, Operation and Maintenance Data, Warranties, and other related certificates.

1.9 SHOP DRAWINGS AND SUBMITTALS

A. Contractor shall submit to the Architect shop drawings, product submittals, and catalog data on all ductwork, equipment, and materials designated on the Drawings and specified herein. A minimum of one (1) electronic copy or three (3) hard copies of each shall be submitted. Additional copies will be required when indicated by the Architect and as required for project coordination.

B. Each submittal will be reviewed for compliance with general requirements of design and arrangement only; it is not a contract document and acknowledgement of compliance does not relieve the Contractor from responsibilities for performance of the work in compliance with all provisions and requirements of the Contract Documents. Job measurements and the coordination of all dimensions for proper fit of all parts of the work and performance of all equipment supplied to meet specification requirements are, and remain, specific responsibilities of the Contractor.

C. Shop Drawings shall be furnished by the Contractor for the work involved after receiving approval on the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job, and failure on the part of the Contractor to comply shall render him liable to stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary detailed drawings. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary; and, should there be any charges in connection with this, they shall be borne by the Contractor.

D. Shop Drawings submitted shall not consist of manufacturers' catalogues or tear sheets therefrom that contain no indication of the exact item offered. Rather, the submission on individual items shall designate the exact item offered and accessories as specified.

E. Shop Drawings are not intended to cover detailed quantitative lists of heating specialties, valves, air distribution devices, fixtures, and similar items, as the Drawings and specifications illustrate those items; and it is the Contractor's responsibility to procure the proper quantities required to comply with the established requirements.

F. Shop Drawings prepared to illustrate how equipment, piping, ducts, etc., can be fitted into available spaces will be examined under the assumption that the Contractor has verified the conditions shown. Review by the Architect shall not relieve the Contractor of responsibility in the event the material cannot be installed as shown on those Shop Drawings.

G. Various material submissions of such items as air devices, plumbing fixtures, drains, and other related items or accessories shall be assembled in brochures or in other suitable package form and shall not be submitted in a multiplicity of loose sheets. Cover sheets for each item submitted shall have sufficient bare space to allow for shop drawing review stamps.

H. Contractor shall process his submitted data to insure that it conforms to the requirements of the Drawings and specifications, and there are no omissions and/or duplications.

I. Shop Drawings and Submittals shall be accompanied by certification from the Contractor, and firm preparing such, that Shop Drawings have been checked for, and are in compliance with, the Contract Documents.

J. All Submittals and Shop Drawings shall have been submitted for review by the Architect and Engineer within 90 days after Contract Award Date.

1.10 PENETRATIONS THROUGH FIRE-RATED ASSEMBLIES

A. Seal voids around ducts and pipes penetrating fire-rated assemblies and partitions using fire-stopping materials and methods in accordance with provisions in Section 07 84 00, Fire-Stopping.

1.11 DRAWINGS

A. Drawings show diagrammatically the locations of the various pipes, ductwork, fixtures, and equipment, and the method of connecting and controlling them. It is not intended to show every connection in detail and all fittings required for a complete system. The systems shall include, but are not limited to, the items shown on the drawings. Exact locations of these items shall be determined by reference to the general plans and measurements at the building, and in full cooperation with work specified in other Divisions of these specifications; and, in all cases, shall be subject to the approval of the Architect. The Architect reserves the right to make any reasonable change in the location of any of this work without additional cost to the Owner.

B. Should any changes be deemed necessary in items shown on the Contract Drawings, the shop drawings, descriptions, and the reason for the proposed changes shall be submitted to the Architect for approval.

C. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention prior to bids being submitted; otherwise, the Contractor shall be responsible for the cost of any and all changes and additions that may be necessary to accommodate the installation of any particular apparatus.

D. Lay out all work maintaining all lines, grades, and dimensions according to these Drawings with due consideration for the work of others. Verify all dimensions at the site prior to any fabrication or installation. Should any conflict develop or installation be found impractical, the Architect shall be notified before any installation or fabrication, and the existing conditions shall be investigated and proper changes effected without any additional cost.

E. Titles of Sections and Paragraphs in these specifications are introduced merely for convenience and are not to be construed as a correct or complete segregation or tabulation of the various units of materials and work. The Architect does not assume any responsibility, either direct or implied, for omissions or duplications by the Contractor due to real or alleged error in the arrangement of matter in the Contract Documents.

1.12 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Equipment supplied as portions of work specified under other Divisions of these specifications shall be furnished with proper roughing-in diagrams and shall be installed as a part of Division 23.

B. Furnish materials and labor required for the connection of this equipment.

C. Contractor shall ascertain that all equipment so specified is included as part of this work.

1.13 COOPERATION

A. Coordinate all work indicated in Division 23 with work specified in other Divisions to assure proper and adequate interface with other portions of the work.

B. Maintain contact and be familiar with the progress of the general construction and the timely installation of sleeves and inserts, etc., before concrete is placed. Install the required systems in their several stages, at the proper time to expedite the work and avoid unnecessary delays in the progress of other portions of the work.

C. Should any questions arise between work specified in Division 23 with respect to other portions of work specified in other Divisions of the Specifications, reference shall be made to the Architect for instructions.

1.14 MATERIALS AND EQUIPMENT

A. All materials and equipment purchased shall be new. No used or reconditioned equipment will be allowed.

B. Substitutions: Products of same functions, performance and design will only be considered if in full accordance with the requirements of Section 01 60 00, Product Requirements. The products of other manufacturers will be acceptable; only if, in the opinion of the Architect, the substitute material is of a quality as good or better than the material specified, and will serve with equal efficiency, maintainability, and dependability, the purpose for which the items specified were intended.

C. Listed Manufacturers:

1. Manufacturers listed in a product or system specification are those manufacturers considered capable of manufacturing products conforming to the specification requirements, and are listed therein to establish a standard.
2. The "listing" of a manufacturer does not imply "acceptance" or "approval" of any standard product of that manufacturer.
3. Products offered by listed manufacturers shall be equal to, or superior in all respects to, that specified by named products; and shall meet or exceed specification requirements.
4. The description of specific qualities takes precedence over the reference standards and the description of qualities and reference standards together take precedence over the named product of listed manufacturers.

D. Product Options:

1. Products specified only by Reference Standards or by Description only means that any product meeting those standards or descriptions, by any manufacturer, will be considered.
2. Products specified by naming several products or manufacturers means that only the manufacturers named will be considered.
3. Products specified by naming only one product and manufacturer means that no option exists unless a substitution is accepted. Submit a request for substitution for any product or manufacturer not specifically named.
4. Products specified by Description, Reference Standard, and naming several products or manufacturers means that any product and manufacturer named meeting those descriptions and standards will be considered. Submit a request for substitution for any product or manufacturer not specifically named.

E. Limitations or Substitutions:

1. During Bidding Period, Instructions to Bidders, in Division 1, will govern times for submitting requests for substitutions under requirements specified in this Section.
2. No later than ten (10) days prior to the bid date, Contractor shall notify the Architect in writing of any desired substitutions of products in place of those specified. These requests will be considered; and, if a favorable response is determined, this will be documented in the form of an Addenda.
3. Substitutions will not be considered when indicated or implied on Shop Drawings or product data submittals without separate formal request, when requested directly by subcontractor or supplier, or when acceptance will require substantial revision of Contract Documents.
4. Substitute products shall not be ordered or installed without written acceptance.
5. Only one request for substitution for each product will be considered. If substitution is not accepted, Contractor shall provide specified product.
6. Architect will determine acceptability of any and all substitutions.

F. It is fully the Contractor's responsibility to assemble and submit sufficient technical information to fully illustrate that the material or equipment proposed for substitution is equal or superior, as the Architect is under no obligation to perform the service for the Contractor. The proposal shall be accompanied by manufacturer's engineering data, specification sheet, and a sample, if practical or if requested or specified. In no event shall a proposal for substitution be cause for delay of work. This shall include a detailed comparison to each product specification paragraph.

G. Should a substitution be accepted under the above provisions, and should the substitution prove defective or otherwise unsatisfactory for the intended service, within the warranty period, the Contractor shall replace the substitution with the equipment or material specified, and on which the specifications required him to base his proposal.

H. No substitutions will be considered contingent upon pending certification and rating agency approvals. Such certifications and ratings shall be in effect at the time of bidding.

1.15 EQUIPMENT SIZES AND REQUIREMENTS

A. Space allocations in machinery and mechanical equipment spaces are based on equipment scheduled in each case. Should the Contractor request a substitution for equipment of another make that requires more space in any critical dimension, the Contractor shall submit, together with other submittal data on the equipment, prints of drawings indicating how the equipment may be installed, indicating room for servicing and revisions in piping or ducting and any other details necessary for the Architect to form a judgment as to the suitability of the substitute material, as to performance, suitability for the space and other variables.

B. Duties of certain equipment items, horsepowers of driving motors and electrical characteristics are scheduled for equipment items of a particular make in each case. Should requests for a substitute material be accepted which has other requirements that would involve allied equipment or other portions of work, the Contractor shall be responsible for all modifications required at no change in contract price. As examples:

1. If an accepted A/C Unit has a brake horsepower requirement above the motor horsepower scheduled, the Contractor shall be responsible for providing a larger motor and heavier drive and any change in size of the protective device, conduit run and conductors serving that motor. The latter shall be extended through an individual branch protective device and branch circuit on through the panel, feeder, feeder protective device, etc.
2. If accepted, heat exchangers, coils, etc., having greater pressure drops than those on which pumping heads were based, the Contractor shall be responsible for selecting proper pumps and drives and adjusting electrical service work accordingly.

C. Structural steel members are indicated to provide supports for certain specific sizes and weights of equipment. Should a substitution request involve other equipment, the spacing of the supports shall be varied to suite the equipment. Should the weight or size of a proposed substituted item of equipment require additional supporting steel members, the Contractor shall include documentation of the additional supports in the request for substitution and install them at no change in contract price if the substitution is accepted.

D. Various large apparatus to be installed may require that the apparatus be installed prior to the installation of portions of structural, walls, or door frames. Coordinate the installation of these items to insure that no demolition of general construction is necessary for equipment installation or that the apparatus does not have to be disassembled for installation.

1.16 STORAGE AND PROTECTION OF MATERIALS

A. Store and protect materials and equipment as specified in Section 01 60 00, Product Requirements.

B. Contractor shall provide storage space for protection and storage of his materials and assume complete responsibility for all losses due to any cause whatsoever. All storage shall be within the property lines of the building site, and as directed by the Architect. In no case, shall storage interfere with traffic conditions in any public or project thoroughfare.

C. All work and material shall be protected at all times. Contractor shall make good any damage caused, either directly or indirectly, by his workmen. He shall be responsible for safe handling of all mechanical equipment and shall replace, without charge, all items damaged prior to acceptance by the Owner.

D. On site storage shall not be inside the building during construction progress, but shall be in approved trailers or as specifically approved otherwise by the Architect. Storage inside the building shall only be allowed when so allowed by the Architect.

1.17 FOUNDATIONS

A. Provide equipment foundations associated with the work specified in Division 23.

B. All top corners and edges of all foundations shall be neatly chamfered at a one inch (1") high 45 degree angle.

C. Foundation bolts shall be placed in the forms when the concrete is poured. Allow one inch (1") below the equipment bases for alignment, leveling, and grouting with non-shrinking grout. Grouting shall be done after the equipment is leveled in place. After the grout has hardened, the foundation bolts shall be pulled up tight and the equipment shimmed, if necessary.

D. After removal of the forms, the surface of the foundation shall be rubbed until smooth.

E. Unless otherwise noted, foundations shall be six inches (6") high for medium pressure rated air handling units, and four inches (4") thick elsewhere for low pressure rated air handling units and other mechanical equipment, unless specifically noted otherwise on the Drawings.

F. All concrete work shall conform to the requirements of Section 03 30 00, Cast-in-Place Concrete.

G. Provide housekeeping pads and foundations for every item of floor mounted equipment specified in Division 23 specifications. Pads shall extend a minimum of two inches (2") in each direction beyond the equipment size.

1.18 EXCAVATION AND BACKFILLING

A. Contractor shall do all necessary excavating and backfilling for the installation of his work. Trenches for underground conduits shall be excavated to required depths with bell holes provided as necessary to insure uniform bearing. Care shall be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where rock or hard objects are encountered, they shall be excavated to a grade six inches (6") below the lowermost part of the piping and refilled to grade as specified. After the piping has been installed and reviewed by Architect and local building authorities, trenches shall be backfilled to grade with approved materials, well tamped or puddled compactly in place. Where streets, sidewalks, etc., are disturbed, cut, or damaged by this work, the expense of repairing same in a manner approved by Architect shall be a part of this contract.

B. Contractor shall bear sole responsibility for design and execution of acceptable trenching and shoring procedures, in accordance with State of Texas Regulations. On trench excavations in excess of five feet (5') in depth, Contractor shall pay a qualified engineer to prepare detailed Drawings and specifications directing Contractor in the safe execution of trenching and shoring. It is understood that trench safety systems constitute a means and method of construction for which the Architect, Engineer, and Owner are not responsible. Accordingly, such documents when prepared, shall be separately issued by Contractor's Consultant, independent of project contract Documents.

C. Where granular bedding backfill is used (includes gravel and sand) provide concrete cut-off collars of clay plugs where ever utility lines cross building lines to prevent water from traveling in the trench backfill and entering beneath the structure.

D. Refer to soils testing report for recommendations on backfill material, compacting instructions and criteria for materials to be used.

1.19 WIRING

A. Unless otherwise noted, all wiring for motors, starters, and equipment is specified in Division 26.

B. Wiring of temperature controls shall be performed in accordance with the requirements of Division 26 but shall be performed as outlined in other sections of these specifications.

C. All power for control circuits required for the Temperature Control System shall be provided and installed where indicated on the Division 26 Drawings, but shall otherwise be provided as indicated in other sections of these specifications.

D. Each supplier of equipment requiring control shall have wiring diagrams furnished with submittals. This shall be used to determine conduit layouts required to complete the electrical portions of the instrumentation and control systems.

E. All motors furnished as a portion of work specified in Division 23 shall be wired as specified in Division 26.

F. Except where combination starter-disconnects are specified elsewhere herein or in Division 26, all motors shall be provided with safety disconnect switches in accordance with the National Electrical Code as specified in Division 26.

G. Furnish all necessary wiring diagrams for equipment specified in Division 23, as a part of equipment submittals, for installation under other sections of these specifications.

1.20 EQUIPMENT STANDARDS

A. All basic materials and equipment shall be standard catalog products of a reputable manufacturer and shall essentially duplicate equipment which has been in satisfactory service for at least one (1) year.

B. First of a kind new technology devices will not be considered.

C. Accessory equipment that is required to make a complete and functioning system that is not of the same manufacturer furnishing the basic materials or equipment shall carry the guarantee of the basic material or equipment manufacturer and repair and replacement parts shall be available through normal trade channels locally.

1.21 DEHUMIDIFICATION OF BUILDING

A. It shall be the Contractor’s responsibility to properly and thoroughly dry out all building materials used for construction of the building, as well as to dry out the building and dehumidify the spaces prior to activating the HVAC System. Extra precautions should be taken by the Contractor not to allow excessive humidity to develop in the building prior to final connection and activation of the HVAC System. Should it become necessary, the Contractor shall procure the required equipment (multiple portable dehumidifiers, as required to include temporary power thereto) to properly dry and dehumidify the building materials and spaces so as not to force the HVAC System to perform beyond its intended abilities.

B. Contractor shall be responsible for all costs in connection with repair and/or activation to the building and its HVAC Systems should excess moisture cause damage thereto.

C. Contractor shall provide proof of dehumidification by furnishing temperature and humidity readings for each section of the building as measured and recorded by an independent agent approved by the Owner/Architect. Provide these readings to the Owner’s representative prior to the building HVAC system being activated and also furnish with the Project Close-Out documents.

D. The inside building Dew Point shall not exceed 55 Deg. F. for a period of 24 consecutive hours or for a total of 24 hours in a 7 day time period.

1.22 CLEAN UP

A. Contractor shall be responsible for cleaning up after and during all work performed under this Division of the Specifications.

B. Contractor shall, on a daily basis, remove construction trash and debris accumulation to minimize the entrance of dust, dirt, and debris in piping, ductwork, and mechanical equipment.

C. At the completion of construction, just prior to Substantial Completion and sustained operation of equipment, thoroughly clean the inside of piping, ductwork, and equipment.

D. Refer to Division 1.

1.23 FINAL CONSTRUCTION REVIEW

A. Schedule: Upon completion of the work specified in Division 23, there shall be a final construction review of the completed mechanical systems installations. Prior to this walk-thru, all work specified in this Division shall have been completed, tested, adjusted, and balanced in its final operating condition and the preliminary test report shall have been submitted to and approved by the Architect.

B. Personnel: A qualified person representing the Contractor must be present at this final construction review to demonstrate the system and prove the performance of the equipment.

C. Building mechanical systems shall have been in operation for a minimum of 15 days and Test and Balance work shall be substantially complete prior to this review.

D. Exceptions to the aforementioned requirements will be considered on a case-by-case basis dependent on the size and type of project, as well as construction schedule limitations.

1.24 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these Specifications.

B. Provide copies of all applicable approved notices and inspection certifications from the various inspections conducted by the Local Code Enforcement Authorities.

1.25 GUARANTEE

A. The guarantee provision of this specification requires prompt replacement of all defective workmanship and materials occurring within one year of final job acceptance, Substantial Completion, or as defined by Extended Warranty Contracts. This includes all work required to remove and replace the defective item and to make all necessary adjustments to restore the entire installation to its original specified operating condition and finish at the time of acceptance.

B. The Contractor shall also guarantee that the performance of all equipment furnished and installed under this Division of the Specifications shall be at least equal to the performance as called for in the specifications and as stated in the equipment submittals. Should there be indication that the equipment and installation is not producing the intended conditions, the Contractor shall make further tests as the Owner's Representative may direct to demonstrate that the equipment installed meets the specifications and is delivering the capacity specified or called for on the Drawings.

C. If there is any indication that the equipment does not meet the specified quantities, the Contractor shall, at his expense, institute a program to demonstrate the adequacy of the installation. This program shall include all necessary testing and testing equipment. Should the Contractor not have the equipment or technical skill to perform the tests, it shall be his responsibility to employ recognized experts to perform the tests and shall provide certified laboratory tests, certified factory reports and work sheets, or other certified data to support results of any tests required.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide motors for all mechanical equipment furnished under Division 23, as indicated herein and as illustrated on the Contract Drawings.

B. All motors shall be of the same manufacture for like pieces of equipment; i.e., air handling units shall have motors of the same manufacturer. Pumps shall have motors of the same manufacturer, but both types of equipment are not required to have the same motor manufacturer.

C. The following equipment with 3 phase 1 horsepower motors or larger shall be provided with NEMA Premium efficiency motors as specified herein:

1. Air handling units.
2. Fan coil units.
3. Pumps.
4. Fans.
5. Larger Split Direct Expansion (DX) A/C units.

D. Three phase, horizontal, NEMA frame induction motors served by AC Adjustable Frequency Motor Controllers shall be designed to meet the intent of NEMA MG1, Part 31, Section 31.40.4.2 regarding voltage spikes without exception.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00 and 23 05 00.

B. Indicate on submittal the motors proposed for each system of equipment to be installed. This shall be in tabular form in one location for each type of equipment submitted. The lack of this information will be grounds for rejection of equipment submittals.

C. Product Data shall be furnished which shall include:

1. Motor Manufacturer.
2. Motor Type; Open Drip Proof, Totally Enclosed (Fan Cooled or Air Over).
3. Model of Manufacturer.
4. Motor Horsepower.
5. Motor RPM.
6. NEMA Motor Efficiency at 25%, 50%, 75%, and 100% of Full Load Rating for motors served by variable frequency drives; 100% only for constant speed motors 1 HP and larger.
7. Power Factor at 25%, 50%, 75%, and 100% of Full Load Rating for motors served by variable frequency drives; 100% only for constant speed motors 1 HP and larger.
8. Service Factor.

D. Certification: Provide manufacturer's literature indicating NEMA premium motor efficiency as tested in accordance with IEEE Standard 112, Test Method B. Provide documentation to verify motors served by variable frequency drives meet NEMA MG1, Part 30 for 6-step drives and Part 31 for PWM drives.

E. Provide closeout documents as required in Division 1.

1.4 QUALITY ASSURANCE

A. Comply with all regulatory requirements in the following order of precedence:

B. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.

C. Provisions specified in this Section of Specifications.

D. Applicable provisions of standards of National Electric Code (NEC).

E. Manufacturer shall have been manufacturing the motors as described herein for a minimum of ten (10) years.

PART 2 - PRODUCTS

2.1 ELECTRICAL MOTORS, GENERAL

A. All motors furnished under any of the several sections of these specifications shall be of a recognized manufacturer, be of adequate capacity for the loads involved, and wound for the electrical characteristics indicated on the Drawings and specified herein. Verify all job site voltages and power source available before submitting, ordering and installing any motor or related controls.

B. Motors shall conform to the standards of manufacture and performance of the National Electrical Manufacturer's Association (NEMA) as shown in their latest publication.

C. Motors shall be furnished with an open-frame, unless otherwise noted, or required by the NEC for the service conditions encountered. Motors exposed to weather shall be the totally enclosed type suitable for installation in ambient conditions for exposure to the sun, heat, and rain. Provide explosion proof motors where indicated and as required for the hazard in which to be installed.

D. Unless otherwise noted, fractional motors rated at 1/2 horsepower and less shall be single phase, the motors rated at larger than 1/2 horsepower shall be three phase. Single phase motors shall be arranged for across-the-line starting.

E. Single phase motors shall be capacitor start, induction run type, and shall be furnished with motor controller with pilot light where scheduled or indicated. Refer to Section 23 05 14.

F. All motors shall be of the same manufacturer on similar equipment furnished by the same manufacturer, unless they are an integral part of the piece of equipment to which they are attached, such as a chiller. Air Handling Units shall have motors of the same manufacture and pumps shall have motors of the same manufacture; but, pumps and air handling units are not required to have motors of the same manufacturer.

G. Three phase motors shall generally have the following characteristics:

1. All copper windings.
2. Type K, NEMA Design "B".
3. Normal Starting Torque.
4. Class B insulation.
5. Continuous Duty Rated.
6. 40 Deg.C. ambient rated.

7. Minimum 1.15 Service factor on motors 1 horsepower and larger; 1.25 service factor on motors 3/4 horsepower and smaller.
8. 1800 RPM unless scheduled otherwise.
9. Oversize steel conduit boxes.
10. Greasable bearings.
11. Stainless steel or aluminum motor nameplates for standard motor information.
12. Cold rolled steel 1045 shaft.
13. Steel frame and splash cover.

H. Where other sections of specifications do not call for premium efficiency motors this section shall apply to motor requirements. Where premium efficiency motors are required in the other Sections of these Specifications refer to Article 2.2 herein.

I. Motor manufacturers shall be Reliance, Baldor, General Electric, A.O. Smith or U.S. Motors. Other manufacturers will not be considered.

2.2 PREMIUM EFFICIENCY ELECTRICAL MOTORS

A. All premium efficiency electrical motors furnished under any of the several sections of these specifications shall be of a recognized manufacturer, be of adequate capacity for the loads involved, and wound for the electrical characteristics indicated on the Drawings and specified herein. Verify all job site voltages and power source available before submitting, ordering and installing any motor or related controls.

B. Motors shall conform to the standards of manufacture and performance of the National Electrical Manufacturer's Association (NEMA) as shown in their latest publication.

C. Motors shall be furnished with an open-frame, unless otherwise noted, or required by the NEC for the service conditions encountered. Motors exposed to weather shall be the totally enclosed type suitable for installation in ambient conditions for exposure to the sun, heat, and rain. Provide explosion proof motors where indicated and as required for the hazard in which to be installed.

D. All NEMA Premium efficiency motors shall be three phase.

E. Except as otherwise specified NEMA Premium efficiency motors shall be drip-proof, squirrel cage, premium efficiency type as manufactured by A. O. Smith (E Plus III), Baldor (Super E), Reliance (Duty Master XE), General Electric (Energy Saver), or U.S. Motors Premium Efficiency NEMA Design B, induction type rated for constant duty with 40 Deg.C. ambient temperature rise. The motors shall have the following characteristics:

1. 1800 RPM unless scheduled otherwise.
2. 1.15 Service Factor.
3. Rigid base.
4. Serialized and certified.
5. Stainless steel nameplate.
6. Class B insulated.
7. 60 Hertz.
8. High power factor.
9. Ball Bearings.

F. Totally enclosed motors and motors served by variable frequency drives shall be Class F insulated.

G. Minimum Nominal motor efficiencies at 1800 RPM, 480V, 4 pole, full-load, per IEEE Standard 112, test method B, as defined by NEMA MG1-12.53, a and b, shall be as follows, along with minimum power factor:

MOTOR HP	NOMINAL EFFICIENCY		POWER FACTOR	
	TEFC	ODP	TEFC	ODP
1	85.5	85.5	84.0	84.0
1.5	86.5	86.5	85.7	85.7
2	86.5	86.5	85.7	85.7
3	89.5	89.5	85.5	85.5
5	90.2	89.5	88.0	88.0
7.5	91.0	91.0	82.0	82.0
10	91.7	91.7	82.0	82.0
15	92.4	93.0	86.0	83.5
20	93.0	93.0	86.5	84.5
25	93.0	93.6	87.5	87.0
30	93.6	94.1	88.5	87.0
40	94.1	94.1	89.0	87.0
50	94.5	94.5	88.5	86.5
60	95.0	95.0	87.0	84.5
75	95.4	95.0	87.0	85.0
100	95.4	95.4	86.0	86.0

H. Furnish submittal data on all NEMA Premium efficiency motors furnished to include motor efficiencies as rated in accordance with IEEE Standard 112, Test Method B.

I. All motors shall be of the same manufacturer on similar equipment furnished by the same manufacturer, unless they are an integral part of the piece of equipment to which they are attached, such as a chiller. Air Handling Units shall have motors of the same manufacture' and pumps shall have motors of the same manufacture; but, pumps and air handling units are not required to have motors of the same manufacturer.

J. Each variable torque motor served by a variable frequency drive shall be capable of operating over a 10:1 speed range.

K. Each premium efficiency motor shall be warranted for a minimum of three (3) years.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motors shall typically be furnished by the manufacturer of the equipment which the motor will serve.

B. Motors shall be factory installed in the equipment and be mounted on equipment bases, wired to a terminal box, connected to the mechanical device to be rotated, and factory run tested.

C. When project schedules will not allow the above due to excessive lead time requirements, the Contractor shall do one of the following all at no additional cost:

1. Locally procure the specified motors, while meeting all of the above requirements, and field install the motors on the equipment in accordance with the manufacturer's installation instructions.
2. Accept factory installed standard efficiency motors and replace with high efficiency motors as noted above.

D. Motors disconnects will be furnished and installed under Division 26, unless integral with, or specified to be a part of, the equipment as indicated elsewhere in other sections of these Specifications. The wiring to the motor and installation of the motor controller, if not specified to be integral with the equipment, as furnished under other sections of these specifications, shall also be installed under Division 26.

E. Interlock and control voltage wiring shall be installed as outlined in other Sections of these Specifications.

END OF SECTION

SECTION 23 05 14

COMMON MOTOR STARTER REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide a complete system of motor starters as indicated herein and as illustrated on the contract Drawings.

B. Provide other devices as indicated for control of motors and interface with automation or control systems, and as further required by the local authorities having jurisdiction.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 05 00.

B. Indicate on submittal the starter type proposed to be used for each system and for the various sizes of motors required to be installed. This shall be in tabular form with attached cut sheets.

C. Product Data:

1. Snap Action Manual Motor Starters.
2. Magnetic Across-the-Line Motor Starters.
3. Control Transformers.
4. Hand-Off-Automatic Switches.
5. Pilot Lights.
6. Number and Type of Auxiliary Contacts.
7. NEMA Enclosure Type.
8. Power and Control Wiring Diagrams.

D. Provide closeout documents as required in Division 1 at Substantial Completion.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:

1. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.
2. Provisions specified in this Section.
3. Applicable provisions and standards of the National Electric Code (NEC).

B. Manufacturer shall have been manufacturing the product proposed to be used as described herein for a minimum of ten (10) years; or it shall essentially duplicate a product line that has been manufactured for that length of time.

C. Source Quality Control:

1. Manufacturer's tests to meet applicable Underwriters' Laboratories, Inc., Standards.
2. Equipment designed and manufactured to meet applicable ANSI, NEMA, and IEEE Standards.

PART 2 - PRODUCTS

2.1 MOTOR STARTERS

A. Except as specified otherwise, a starter providing overload protection shall be furnished with each motor provided in Division 23, under this section of the specifications, unless:

1. Starters are supplied as an integral part of the specified piece of equipment, such as chillers or boilers; or
2. Starters are provided as specified for a variable frequency motor controller, or
3. Starters are provided in Division 26 as part of a motor control center, or
4. Starters are furnished under Division 26 as a combination motor starter-disconnect.
5. Disconnects on fractional horsepower motors are not substitutes for a motor controller (starter). However, a motor controller on these size motors may substitute for a disconnect only where the required location for both is in the same location.
6. Fractional horsepower motors on VAV terminals are not required to have motor starters furnished herein.
7. Unit heater and ceiling fan fractional horsepower, motors, 1/8 HP or smaller, with inherent thermal overload protection are not required to have motor starters.

B. Each starter furnished herein shall have a NEMA horsepower capacity rating within the required limits of the motor which it serves.

C. Unless otherwise indicated, starters mounted indoors shall be furnished with NEMA Type 1 enclosures, and those exposed to the weather shall be furnished with NEMA Type 3 enclosures.

D. Each three phase starter shall be provided with three thermal overload protection relays, one in each phase, be of the full voltage, across-the-line, non-reversing, single or two-speed, magnetic controller type. Overload relays shall be reset from outside the starter enclosure by means of an insulated bar or button.

E. Starters shall have auxiliary contacts as required to comply with provision for electrical interlocks as defined hereinafter. Provide a minimum of one (1) normally open (N.O.) and one (1) normally closed (N.C.) auxiliary contacts with each three (3) phase starter. Where used, the secondary side of the control transformer shall be grounded and the other side shall be fused. Where starters are interlocked, the starter holding coils shall be of one voltage. Where starter line voltages are different and above 120 volts to ground, provide control voltage transformers in the starters that are interlocked. The control systems installer shall supply all electrical power supply and transformers as needed to serve control circuit requirements for temperature controls. Control voltage in each starter shall be not more than 120 volts to ground, with an individual control transformer provided in each interlocked starter. Control safety circuits shall de-energize the respective motors served via holding coils in the respective starter.

F. Manual starters for fractional horsepower single phase motors shall be on-off, or snap action switch type combined with thermal overload device. The switch shall be so constructed that it cannot be held closed under a sustained motor overload. This shall be equal to an Allen Bradley No. 600-TAX216, toggle switch with neon pilot light and NEMA 1 enclosure unless indicated otherwise for severe duty.

G. Provide starter covers with Hand-Off-Auto Switch and pilot light where equipment is interlocked or remotely controlled. Provide starter covers with Start-Stop buttons and neon pilot lights where equipment is locally controlled.

H. The Hand-Off-Auto Switches shall be so wired that, when in automatic position, the control of their motors is transferred to the control system as outlined elsewhere herein; and, when in hand position, they themselves assume control of their motors irrespective of the remainder of the equipment, although the temperature control sequences shall operate the same while in either the "Hand" or "Auto" position. Safety devices will not be bypassed when in "Hand" position.

I. Coordinate the purchase of all starting equipment, insofar as practical, such that all starting equipment on the project shall be of the same manufacturer.

J. Starters shall be a regularly manufactured product to meet the intent of all requirements specified herein.

K. Acceptable starters and controllers shall be manufactured by

1. Allen-Bradley.
2. General Electric.
3. Cutler-Hammer.
4. Square D.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All starters furnished under this section of the Specifications shall be installed under Division 26 of the specifications.

B. Securely mount all starters level against walls where shown to be fully accessible and convenient for use. Where not specifically shown locate in a convenient and fully accessible location in a Mechanical Room, Electrical Room, Janitor Closet, Storage Room or above accessible lay-in ceiling when no higher than six inches (6") above the finished ceiling height and mounted to a wall or physically secure and stable surface.

C. Where no wall exists for installation, furnish a unistrut fabricated stand secured to the floor, or other suitable structure. Use corrosion resistant fasteners.

D. Where motor starters are ganged together, mount, insofar as is practical, all at the same distance from the floor, or other referenced point, to the bottom of the starters.

E. Refer to manufacturer's wiring diagrams for proper wiring procedures.

F. Wire all safety devices in series to be active in both the "Hand" and "Auto" position.

G. Coordinate starter type and size with motor manufacturer's data for equipment actually installed.

H. Field verify correct sizes of replaceable thermal overload elements for each motor actually installed. Do not over or under size elements.

END OF SECTION

SECTION 23 05 15

COMMON VARIABLE FREQUENCY MOTOR CONTROLLER REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other portions of the work.

1.2 SYSTEM DESCRIPTION

A. Furnish and install variable frequency motor drives (controllers) to provide motor speed control for air handling, pumping and cooling tower systems as indicated on the drawings or as scheduled for equipment with all apparatus, specialties, controls, etc., to make the systems complete.

B. Drives shall all typically be the Pulse-Width-Modulated (PWM) AC type drives. Three phase input power shall be converted to a sine-coded, variable frequency output, used for optimized speed control of induction motors.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. The manufacturer of the variable frequency motor controller shall have a minimum of fifteen (15) years' experience in the design, construction, and application of adjustable frequency controls for heating, ventilating and air conditioning applications.

C. All controllers, with factory mounted options, shall be UL (508C), ETL or CSA certified.

D. All drive manufacturers shall require local supplier representation within 50 miles of the job site, and a suitable service organization capable of repairing equipment within a 24 hour period of notification.

E. All drive manufacturers shall generally have a full line of locally stocked drives with similar features and in sizes consistent with those specified for emergency 24 hour replacement.

F. All VFD's shall have a minimum mean time between failure ratings of no less than 150,000 hours.

G. All drives to be installed in a return air plenum shall be rated for installation in plenum conditions in accordance with U.L. Standard 1995 or UL 508C (Plenums). The UL listing shall allow for mounting in plenums or other air handling compartments. The NEMA rating of the enclosure shall be whatever is necessary to comply with this requirement.

1.4 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 23 05 00.

B. Clearly identify all options furnished including detailed wiring diagrams indicating required field connections and wiring to be provided under Division 26 and for Temperature Control System interface.

C. Submittal shall include a list of each specification section paragraph number and notation on each specific feature, function or method of operation in which compliance is intended. Lack of compliance with this requirement will be cause for rejection of submittals.

1.5 PRODUCT HANDLING

A. Storage, handling, and protection of materials shall be in accordance with Section 23 05 00. All drives shall be completely wrapped at the factory with a semi-dust tight enclosure, similar to a heat shrink plastic, to prevent dust and debris from getting into the drive enclosure. Drives shall continue to be protected during construction in a similar fashion and be stored in a dry clean location.

B. The drive shall be wrapped with a low efficiency polyester media filter when power is supplied to the drive and when operated during the construction period. Filter shall be cleaned or replaced regularly to prevent overheating of the drive and electronics.

C. All materials or equipment damaged during transit, handling, or installation shall be replaced at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. The variable frequency controllers furnished shall convert 480, 240 or 208 volt (Refer to and verify from Plans and submittals), +10 to -5%, three-phase, 60 Hertz, + 3% utility power phase to phase imbalance to adjustable voltage and frequency, + 1%, three phase A-C power for stepless motor control from 10% to 110% of base speed under variable torque load.

B. All general options and modifications shall mount within the standard adjustable frequency motor controller enclosure unless otherwise specified or in an integrally mounted expansion module.

C. Variable frequency drive systems shall not cause any radio, television, computer, or other communication system interference within the building in which it is installed. All drives shall meet the requirements of Radio Frequency Interference (RFI) above 7 MHz as specified by FCC regulations, Part 15, Subpart J, Class A devices. All drives shall include EMI/RFI filters.

D. The service voltage distortion shall be limited to 5% peak to peak. All drives shall comply with interference and distortion requirements contained herein. If, after units are installed and distortion or interference is traced back to the VFD Units, equipment manufacturer shall install isolation transformers or input line reactors at no cost to the Owner to eliminate the objectionable interference. All PWM drives shall have a minimum 5% line impedance, via, a 5% input 3 phase A.C. line reactor, 5% DC bus reactor, or a 3% input 3 phase A.C. line reactor combined with a 3% DC bus reactor.

E. All drive systems shall be capable of installation in long term operation in a mechanical room environment with a temperature range of 32 degrees F. to 104 Deg.F., a humidity level of 0% up to 95% non-condensing relative humidity, and be rated for the altitude applicable to the job site.

F. Enclosures shall have a minimum NEMA 1 rated metal enclosure, unless indicated otherwise elsewhere herein.

G. For outdoor applications, such as for roof mounted air handlers, provide a NEMA 3R outdoor rated enclosure suitable for direct exposure to the sun. Provide mounting feet for enclosure where the enclosure is free-standing and where indicated on the Drawings. Provide a sun shield cover and suitable rain protected vent openings for ventilation of the electronics. Drives installed in outdoor enclosures shall be derated for elevated ambient conditions of up to a minimum of 110 Deg.F. Provide a heater in the enclosure to prevent condensation.

H. VFD's shall be capable of withstanding the following conditions without failure or mechanical damage:

1. Being disconnected under full load.
2. Single phasing or phase failure on both Input and Output.
3. Loose wiring on load or line side main connections.
4. Shorting between terminals on the same terminal board.

5. Being disconnected and/or make disconnect on a coast down of equipment.
6. Be able to be energized, pick up a motor load, with a spinning fan wheel, as an example.

I. Variable frequency drives shall be the pulse width modulated (PWM) type as **manufactured by ABB, Danfoss, Trane or Yaskawa**. All drives shall be of the same manufacturer unless the drive is furnished integral with a factory made piece of equipment.

J. All motors connected to drives shall have individual dedicated drives, Two (2) or more motors shall not be controlled by one (1) drive.

2.2 VARIABLE FREQUENCY DRIVE FEATURES

A. Drives shall include as a minimum the following:

1. Converter, inverter, regulator with replaceable plug in circuit boards.
2. Hand-off-auto selector switch or buttons.
3. Manual speed (frequency) selection.
4. Independently tuned acceleration and deceleration ramps (0-600 seconds).
5. 6-66 Hz controlled speed range.
6. Annunciator for remote indication of fault conditions. Store up to the last 10 faults that have occurred in the drive control panel.
7. All protective circuits and features as recommended by the manufacturer.
8. Frequency meter mounted in the door or on the enclosure or displayed on control panel display.
9. Electronic 4-20ma input signal receiver, with transceiver as required to interface with the temperature control system, adjustable for direct or reverse acting. Provide internal drive limits to prevent drive from exceeding 60 Hertz or dropping below minimum drive speed when the input signal exceeds 20ma or drops below 4ma, respectively.
10. Output contactor (for positive motor disconnect).
11. Plug-in tester card and meter unless all trouble shooting can be accomplished via control panel display and keypad.
12. Recommended replacement modules per operations and maintenance manuals.
13. Non-resettable elapsed time meter to indicate run time of connected load/motor (not power on to drive).
14. Input line fuses, Class J.
15. Automatic shut-off for overload conditions.
16. Output thermal overloads (one in each phase).
17. 115 VAC Control Power transformer with fused primary where required for the external control circuit. Coordinate requirement with Section 23 09 00.
18. Field adjustable input signal offset bias control device.
19. Auxiliary contacts for connection to an Energy Management System. Provide up to 2 analog outputs, 3 digital inputs and 3 output relays. Refer to Section 23 09 00, Controls and Instrumentation.
20. Standardized communications interface card suitable for connection to the specified Energy Management System (EMS), an embedded Building Automation System protocol for network communications. Refer to Specification Section 23 09 00 for requirements.
21. Electronic Ground Fault Protection shall be provided for all operating conditions to include initial power applied up to full speed and full load conditions.

B. Provide manual constant speed bypass switch with magnetic across the line starter, to include overload relays, and disconnects to allow the motor to open across the line in the event of VFD shutdown and to allow for a maintenance or service person to safely repair/service the drive while the load is operated by the starter. Provide drive output isolation contactors and bypass contactors to accomplish this function.

C. Provide time delay in switch-over circuitry to allow running motor to coast to stop when switched from drive to starter and vice versa. Additionally provide an integral input power supply disconnect on all drives. Bypass features shall include a control safety circuit terminal strip, 115 VAC control transformer, a Drive/Bypass selector switch, Hand-Off-Auto Switch, and indicating LED lights for BYPASS ON, Control Power ON and Drive RUNNING. Either 3 contactor bypasses are acceptable or 2 contactor bypasses with service switch and fast acting fuses (NEC approved disconnect switch to service drive) will be allowed.

Where physical space for bypass is not available when drives are to be installed inside roof mounted air handler control sections, then a bypass will not be required.

D. Variable frequency drives shall be of the pulse width modulation type provided the minimum number of pulses per output cycle is at least 5000 at 30 hertz and below to minimize motor heat and noise

E. Provide auto restart package on each drive to restart the motor when power resumes after a power interruption. A minimum of five (5) attempts at restart shall occur before the drive goes into a fault condition.

F. Provide a minimum of three (3) critical speed coast troughs for all fan drives.

G. Provide bus capacitors, or equivalent feature, for minimum 500 millisecond power loss ride-through capabilities at a minimum of 50% load.

H. Provide components necessary for maintaining a high input power factor, with a minimum displacement angle of 0.95, over the entire range of operating speeds and loads.

I. Minimum drive efficiency shall be 95% at 50% speed and 97.5% at 100% speed conditions without exception.

J. Drives shall be rated to withstand 110% of full load amps of connected motor size for up to one (1) minute (60 seconds) and 150% of rated full load amps instantaneously.

K. VFD’s and bypasses shall each have a minimum short circuit rating of 65K amps RMS where circuit breaker disconnects are employed and 100K amps RMS when drives employ fused disconnects, all without additional input fusing.

L. The starting torque shall be 100% available from 0.5 Hertz up to 60 Hertz output operating frequency.

M. Provide for DC injection braking to prevent fan “wind milling” at a start or stop command, adjustable, with current limited, on all drives serving fans.

N. All programming memory shall be saved when the VFD power source is disconnected. This shall require that all memory for the purpose be non-volatile memory (NV RAM).

O. Provide an automatic energy saving, reduced voltage operation, when the drive has been de-energized, no command to “run”, for a pre-determined time frame, adjustable. This shall be the equivalent to a sleep mode function.

2.3 ELECTRONIC COMPONENTS QUALITY ASSURANCE

A. All printed circuit boards shall be tested under a temperature cycling (0 Deg.C. to +65 Deg.C.) load test and then functionally tested via fault finder bench equipment prior to unit installation.

B. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults and drive shall trip electronically without device failure.

C. Each VFD shall be put through a 30-minute cycling motor load test before inspection and shipping.

D. Certification that all of the testing above has been performed shall be provided by the drive manufacturer.

E. Conduct in circuit testing of all printed circuit boards to insure the proper mounting and the correct values for all electronic components.

F. Final printed circuit board assemblies shall be functionally tested, via computerized test equipment. All tests and acceptance criteria shall be pre-programmed. All test results shall be stored as detailed quality assurance data.

G. All fully assembled controls components shall be functionally tested, with fully loaded induction motors. The combined test data shall then be analyzed, to insure adherence to identified quality assurance specifications.

H. Inspect and perform a production test, under load, for each completed VFD assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The motors and drives approved shall be shipped to the job site as scheduled and installed under the supervision of a factory trained manufacturer's superintendent. The manufacturer shall furnish all control and wiring diagrams for inclusion in the temperature control system shop drawings. The electrical wire, wiring and termination work shall be done under Division 26 for power wiring and Section 23 09 00 for temperature control wiring, coordinating all work with and under the supervision or instruction of the drive equipment manufacturer's representative.

B. A variable frequency controller shall be provided as indicated on the schedule for each AHU supply fan and for each individual pump as scheduled.

3.2 SERVICE

A. The manufacturer shall provide the following services performed by a factory authorized and fully trained representative only.

1. Factory coordinated start-up service.
2. Training of Owner's personnel in basic trouble-shooting.
3. Training shall be on site and shall be a minimum of four (4) hour duration and shall be performed in addition to start-up of system on a different day after completion of test and balance work.
4. Visit the facility two (2) times during the warranty period, once six (6) months after and once twelve (12) months after the warranty period to perform check-out and maintenance of drives, make any required adjustments and replace any components found to be defective. Report to the Owner in writing outlining work performed.

B. Furnish spare parts list.

C. Provide a three (3) year parts and labor warranty for all drives beginning at Substantial Completion. Warranty shall also include travel and lodging expenses for warranty repair personnel as required. All units shall be installed and checked out to be operating as recommended by the manufacturers authorized and factory trained start-up agent before warranty begins. This includes completion of a factory authorized representative start-up report. Submit completed start-up reports with close-out documents.

END OF SECTION

SECTION 23 05 33

HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. Provide heat trace systems which are specified for the control of freeze protection for the piping systems specified herein and as indicated on the Drawings.

B. Provide a piping insulation system over heat tracing as specified in Section 23 07 00.

1.3 QUALITY ASSURANCE

A. The installation of all heat trace systems shall be performed prior to any insulation work being performed using heat trace materials which are the product of reputable manufacturers.

B. The application of these systems shall be in accordance with the published standards of the manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

C. Materials shall be manufactured by Chromalox or Raychem.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions to allow review of Materials and Methods to ensure complete compliance with specifications.

B. Shop Drawings: Submit materials to be used and method of application for each system in tabular form. General statements not specifically identifying means or methods to be used shall be cause for rejection. Submit a copy of the piping Shop Drawing related to the requirement for Heat Tracing and identify piping to receive heat trace, size of heat trace used on each system, method of installation (straight, spiral wound, etc.), limits of heat trace per electrical circuit and the location of all power connection kits.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 SELF REGULATING HEAT TRACE

A. Furnish and install self-regulating rapid-trace heating cable. Coordinate electrical characteristics, voltage and circuit load (in amperes), and points of service for heat trace circuit, with the electrical systems installer.

B. Heat trace shall be the variable wattage type that adjusts its output based on the temperature to which it is exposed along its length.

C. Overlapping of sections shall be permissible and shall not cause overheating or deterioration. Sections shall be capable of being cut to length without effecting its heat output.

D. Heat trace shall be constructed of a conductive polymer core whose electrical resistance varies with temperature. Upon an outside temperature drop, the core's heat output shall increase and vice-versa. The jacket shall be a flame retardant insulation jacket made of thermoplastic polymer resistant to water and mild chemical attack.

E. Heat trace shall be installed on the following systems located outdoors or when located inside areas of the building subject to freezing:

1. Chilled Water Piping

F. Heat trace shall be rated for the maximum maintained pipe temperatures encountered in each system and shall have a minimum heat output rating of five (5) watts per foot at 120 Volts, single phase power unless otherwise approved by the Engineer.

G. Accessories:

1. Furnish end caps for each circuit to close end of heat trace circuit and run heat trace full length of pipe. Additionally, provide approved splices (using manufactured splice kits) where a circuit consists of different lengths connected together. Heat trace shall be installed beneath pipe insulation.
2. Furnish a thermostatic control device, adjustable, for each heat trace circuit and set at 35 Deg. F. Control devices shall be furnished by the heat trace manufacturer and shall include magnetic contactors and overload heaters, if required.
3. Provide a power connection box for each heat trace circuit.
4. The use of power connection kits with integral thermostats is encouraged to eliminate field wiring for control circuits.

H. Size all heat tracing to protect all water filled piping outdoors to -10 degrees F. by wrapping with heat trace wire with thermostats strapped to lines.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS

A. Do not apply heat trace until all piping has been installed, tested, and leaks repaired.

B. After piping is leak-free, clean off pipe and wipe dry to be free of moisture.

C. Apply heat tracing in sufficient wattage size and wrap factor to meet specified protection level.

D. Attach heat trace to pipe in accordance with manufacturer's instructions. Do not kink, bend, or break cable.

E. Wrap valves and specialties along with piping to make a continuous system.

F. Splice heat trace with specified splice kits.

G. Connect heat trace to power supply through a power connection kit and thermostat, all of which shall be rated for outdoor use.

H. Energize heat trace system and set thermostat at 35 Deg. F. Verify correct operation and repair any breaks in continuity until system is fully operational.

I. Insulation of piping system over heat trace is specified in other sections of these specifications.

END OF SECTION

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. A complete system of vibration isolation for all mechanical equipment subject to the transmission of noise and vibration to the building.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality and have been manufactured by a firm with a minimum of five (5) years of experience in this field.

B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the equipment and vibration isolation manufacturers.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions for all vibration isolation equipment.

B. Shop Drawings: Submit in accordance with Section 23 05 00.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

C. Install materials and equipment at the proper time to keep pace with the general construction and the work of other trades involved so as not to delay the project completion schedule.

PART 2 - PRODUCTS

2.1 GENERAL

A. Objectionable vibration or noise created in any part of the building by the operation of any equipment furnished and/or installed under Division 23 will not be permissible.

B. Contractor shall take all precautions against the same by isolating the various items of equipment, pipes, and ducts from the building structure and by such other means as may be necessary to eliminate the transmission of excessive vibration and objectionable noise produced by any equipment installed thereby.

C. Design all foundations, supports, etc., for equipment, piping and ductwork with this end in view.

D. Contractor shall supervise and instruct the construction of all foundations and supports, in order that they may be constructed in such manner as to prevent the transmission of noise and vibration.

2.2 APPLICATIONS

A. Isolating material shall be selected in each case in accordance with the manufacturer's recommendations and the latter shall be prepared to demonstrate, upon request of the Architect, the isolation effectiveness of the material which has been installed upon his recommendation.

B. Isolators shall be so selected that when all the items in each of the mechanical rooms are in simultaneous operation, the vibration transmission to the building at the lowest disturbing frequency shall be limited to a maximum of 10% for a mechanical equipment room floor that is on the ground and 5% for all other building surfaces, including those in fan rooms, from all the equipment when the various items are in harmony.

C. Isolators for supporting floor mounted equipment (where not internally isolated) shall be of the open spring type with ribbed pads bonded to the underside of the base plate. Similar to Amber Booth type SW-2 with a minimum two inch (2") deflection. All air handling units are internally isolated, except for those handling less than 6500 CFM. For air handling units that are internally isolated, provide vibration isolation pads to be placed under the entire unit, plenum, and accessories so that there is no metal-to-concrete contact. Additionally, provide waffle style neoprene isolation pads beneath all floor mounted air handling units to include plenum and duct sections supported from the floor. Resilient pads may be either elastomeric, rubber-like, or compressed fiberglass with water resistant outer wrapping. Pads may be ribbed or waffled, and may vary in thickness from 1/4" to 1-1/2". Alternating layers of pads and steel shims will be allowed where an increased thickness or deflection is needed. Pads shall be sized to operate within the loading range of the manufacturer in pounds per square inch, and be loaded in the upper half of this range.

D. Isolators for supporting Air Handling Units and Fans suspended from the construction above on rod hangers, not internally isolated, shall be of the open spring type with housings and noise washers, lock washers, nuts, etc. Isolators shall be similar to Amber Booth type BSW-1 or 2 or KDXW-1 or 2 with a minimum 1 inch deflection for fans and fan coil units and 2 inch deflection for air handling units. For fans and fan coil units less than 1000 CFM in capacity they may be isolated with rubber-in-shear isolating grommets in lieu of spring isolators.

E. Each pipe connected to a floor mounted pump and to an item of equipment mounted on external vibration isolators shall have a sufficient number of spring hangers to permit compensation for movement of the piping and equipment, but in no case shall there be less than five (5) per pipe. These spring hangers shall also serve to dampen vibration transmission to the building. Provide other spring hangers for pipes, compensators, etc., as required to comply with the vibration transmission limits listed hereinbefore. In central plant mechanical rooms all piping within these rooms shall receive spring isolators. Isolators shall be similar to Amber-Booth BSW-1, BSS-1, BS-1 or KSX-1.

F. Pumps shall be mounted on inertia pads mounted on recessed spring isolators with a minimum 2 inch deflection and ribbed neoprene pads bonded to base plate. Inertia pads shall be set on 4 inch thick concrete housekeeping pads. Inertia bases shall extend to below pipe elbows for elbow base supports. Bases shall be manufactured for specific application to pumps. Bases shall be the bolted modular type, with springs not extending beyond base. Base shall be made of structural steel with reinforcing steel within for field poured concrete. For double suction pumps, use "T"-shaped bases. Bases shall be same as Mason Industries BMK-6 Series with height saving spring brackets.

G. Boilers, Chillers, condensing units or other equipment to be installed on concrete foundations, housekeeping pads or roof supports shall be mounted on ribbed neoprene pads equal to Amber Booth Ampad Type NR or NRC, Style B isolators.

H. For all curb mounted fans and condensing units, use two inch (2") wide x 3/8" thick neoprene isolation strips to be in continuous contact at all curb to equipment contact areas.

I. For roof-top air conditioning unit OAU-B1; provide spring violation curbs. Spring isolation curbs shall have a minimum static deflection of 2”. The curbs shall incorporate an acoustical isolation package and be equal to Mason RSC-22-3W with RSC-dB option or Thycurb-Vibrocurb II: Lock down any internal spring isolators on supply fans that this unit may have.

J. For Relief Air Fans RF-BG, B1, B2, and C1 provide spring violation curbs. Spring isolation curbs shall have a minimum static deflection of 2”. The curbs shall incorporate an acoustical isolation package and be equal to Mason RSC-22-3W with RSC-dB option or Thycurb-Vibrocurb II.

K. For Grease Exhaust Fans GF-B1, B2, and B3 provide spring violation curbs. Spring isolation curbs shall have a minimum static deflection of 2”. The curbs shall incorporate on acoustical isolation package. Curb shall have a galvanized steel grease and heat shield to protect the spring isolators with an EPDM cover applied after the springs are set that is UV resistant. Curb shall be similar to TECO.

2.3 MANUFACTURER

A. Isolating material used shall be equivalent to Amber-Booth, Peabody, Korfund Vibration Mountings, Kinetics, or Mason. Vibration Isolation Roof Curbs shall be TECO, Mason, Thycurb Vibrocurb, Kinetics, or other Engineer approved manufacturer.

PART 3 - EXECUTION

3.1 PERFORMANCE OF ISOLATORS

A. Comply with recommendations set forth by the American Society of Heating, Refrigerating and Air Conditioning Engineers for the selection and application of vibration isolation materials and units.

B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

C. Place isolators where indicated and where specified herein. Coordinate all isolator selections with approved equipment and other pertinent shop drawings of exact equipment to be isolated. Verify to ensure accuracy of load points and take into account any accessory devices adding to equipment loads to be supported by isolators.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC DUCTWORK, EQUIPMENT AND PIPING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other portions of the work.

1.2 SYSTEM DESCRIPTION

A. Provide a complete system of Piping and Identification as specified herein for each of the systems as described herein.

B. Provide a complete system of valve identification by the use of tags as described herein.

C. Provide a complete system of equipment identification tags as described herein.

1.3 QUALITY ASSURANCE

A. The installation of all mechanical system identification devices shall be performed under this Section of the Specifications using materials which are the product of reputable manufacturers. The application of the materials shall be in strict accordance with the published standards of the manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

B. Manufactured Piping Identification markers, equipment name plates and valve tags shall be a product of Seton Name Plate Corporation, EMED Company, Inc., or Craftmark Identification to meet all ANSI Standards pertaining thereto.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions in accordance with Section 23 05 00.

B. Shop Drawings:

1. Submit a list of all piping and systems to be identified, color of background to be used, legend or wording to be displayed for each system, and the intended location of all markers to be displayed.
2. Submit a list of equipment to receive identification tags, cut sheets and proof copies of tags which indicate location of tag and wording to be engraved thereon.
3. Submit a list of valves with location, indicate type of service, type of tag, tag number and proposed valve tag chart as specified herein.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 PIPING IDENTIFICATION SYSTEM

A. Furnish piping identification markers for all insulated and uninsulated piping systems in sizes and colors in accordance with ANSI Standard A13.1. Markers shall be as manufactured by Seton Name Plate Corporation similar to their vinyl plastic "Setmark" pipe markers with flow arrows. For systems with overall outside diameters under 6" use the snap-around markers. For systems with overall diameters 6" and over use strap-around markers attached with nylon ties.

B. Markers shall be provided as a minimum for the following systems:

1. Primary Chilled Water Supply (Green background)
2. Primary Chilled Water Return (Green background)
3. Chilled Water Supply (Green background)
4. Chilled Water Return (Green background)
5. Chemical Supply (Yellow background)
6. Chemical Return (Yellow background)
7. Make-Up Water (Green background)
8. Expansion (Green background)
9. Drains (Green background), for all insulated drains not contained in one space or roof; i.e., an A/C condensate drain in a fan room shall not require identification, whereas, as drain extending to another space would.
10. Heating Water Supply (Yellow background)
11. Heating Water Return (Yellow background)
12. Refrigerant Suction (Yellow background)
13. Refrigerant Liquid (Yellow background)

C. Refer to Section 09 90 00 for color code paint requirements for all exposed mechanical equipment and piping.

2.2 EQUIPMENT IDENTIFICATION

A. This Contractor shall provide identification plates similar and equal to Seton Name Plates, Style 15671(M4564).

B. Name plates shall be a minimum of 1/16" thick flexible multi-layered acrylic and be 1" X 3" in size with beveled edges. The surface shall be a black satin with a white core for lettering. Other color combinations may be used for specific systems where warranted. Each plate shall be drilled with two mounting holes sized for 3/8" No. 3 round head nickel plated steel screws. Lettering shall be a minimum of 3/16" high and lettering shall be cut through the black surface to the white core and be “Gothic Normal”. Only name plates equal to those specified will be considered. No punched plastic tape or engraved aluminum plates are acceptable. Stick-on only plates are not acceptable.

C. Provide and install identification plates on the cover of all starters or disconnects or combination starter-disconnects, where not mounted directly on the equipment, delivered by the mechanical system installer to the electrical systems installer and on each piece of Mechanical Equipment to include but not necessarily limited to:

1. Pumps.
2. Air Handling Units.
3. Split Direct Expansion Indoor (Fan Coil) A/C Units.
4. Remote Air Cooled Condensing Units.
5. Exhaust Air Fans.
6. Chillers.
7. Boilers.
8. Variable Frequency Drives.
9. Electric Unit Heaters.
10. Fan Powered Terminal Units.

11. Single Duct Terminal Units (with and without heat).
12. Outside Air Intake Hoods.
13. Relief Air Fans.
14. Airflow Monitoring Stations.
15. Expansion Tanks.
16. Chemical Shot Feeders.
17. Fan Coil Units.
18. Rooftop AC Units.
19. UV Light Arrays.
20. Bi-Polar Ionizers.

D. Name plates shall have complete words describing equipment type, use and service. As an example, air handlers shall be designated "AHU-S-X MEP Shop" to designate the equipment as an air handler, number of air handler and area served. Use multiple or larger name plates as required to fulfill this requirement.

2.3 VALVE TAGS

A. Wire onto the handle of each valve installed a 19 gauge brass disc not under one and one-half inches (1-1/2") in diameter stamped with 1/4" high black paint filled letters over 1/2" high black paint filled numbers. Use "PLBG" as letters for Plumbing Valves, "AC" or "HVAC" for Air Conditioning System Water Valves or "FP" for Fire Protection Valves, followed by an identifying number. Tags shall be equivalent to Seton Style 250-BL.

B. Secure valve tags to valves by use of brass "S" hooks or brass jack chains.

C. The number, location, and purpose corresponding to each valve shall be listed in sequence, properly typewritten on a schedule sheet to be turned over to the Owner.

D. Provide two (2) framed valve tag charts with typed schedule sheets contained therein. Charts shall have an aluminum frame with clear plastic or Lexan window.

2.4 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

A. Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping or utilities. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3 inches minimum in width, color coded for the utility involved with suitable warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Provide for underground condenser water piping systems.

B. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

2.5 COLORED PVC JACKETING AND PIPE PAINTING IDENTIFICATION

A. The Contractor shall provide colored PVC Jacketing on all new insulated piping installed. Product shall be similar and equal to Proto Corp. PVC, Style Vinalum Exotuff PVC Lo Smoke Color PVC. Colored Jacketing shall be used in all Mechanical Rooms and Crawlspace areas.

1. Jacketing shall be provided as a minimum for the following systems:

2. Chilled Water Supply/Primary Chilled Water Supply (Dark Green)
3. Chilled Water Return/Primary Chilled Water Return (Light Green)
4. Make-Up Water (Dark Blue)
5. Drains (Grey)
6. Heating Water Supply (Dark Red)
7. Heating Water Return (Light Red)

Chemical Supply (Brown)
Chemical Return (Tan/Light Brown)
Expansion (Light Blue)

B. Where condenser water or drain lines are not insulated in plant, paint all ferrous piping comparable color to specified PVC jacketing throughout the extent of the scope of new construction.

2.6 EQUIPMENT LOCATION IDENTIFICATION

A. All equipment located above a ceiling shall be provided with an identification tag located directly blow it. In areas with drop ceiling, tags shall be riveted to closest metal ceiling angle.

B. Location tag shall be Phenolic type material that is abrasion, heat, stain, and chemical resistant. Constructed of multi-layered acrylic, 3-ply, 1/16” thick with a low glare satin finish. Tags shall have pre-drilled holes on each end to accept a standard rivet size.

C. Color of tag shall be white background with black lettering in all standard ceiling areas. Where there are units above wood grain type ceilings, the tag shall be black background with white lettering.

PART 3 - EXECUTION

3.1 PIPE MARKER INSTALLATION

A. Provide flow arrows at each marker location.

B. Markers shall be spaced not more than 30 feet on center and at each change of direction but not more than 4 feet in each direction from each elbow and tee. Markers not required on piping runouts less than four feet (4') in length and 1-1/4" or smaller in size.

C. Identification markers shall be installed on all new piping; indoors and outdoors.

D. Install markers on exposed piping systems only after jacketing systems and finish paint coats are complete. Refer to Sections 09 90 00 and 23 07 00.

3.2 IDENTIFICATION TAG INSTALLATION

A. Secure tags level and in a conspicuous location with adhesive on equipment starters or combination starter disconnects and on the equipment where starters are not immediately adjacent to the equipment served.

B. Additionally, secure all tags with screw fasteners after secured with adhesive.

3.3 VALVE TAGS

A. Secure Valve tags to each valve with Brass "S" hooks or jack chains on each valve stem corresponding to the valve tag chart list.

B. Secure Valve Tag Chart List to Central Mechanical Room wall near the main entry at 60" above finished floor or where otherwise directed by the Architect. Provide second chart to Owner for their disposition.

3.4 PVC JACKETING INSTALLATION

A. Install similar to method noted in section 23 07 00 for standard white PVC jacketing, except that all piping, regardless of height, noted above shall be jacketed throughout extent of new piping installation in all exposed areas.

3.5 EQUIPMENT LOCATION IDENDTIFICATION TAG INSTALLATION

A. Secure tags level and on ceiling grid with adhesive and rivets.

END OF SECTION

SECTION 23 05 66

ANTI-MICROBIAL ULTRAVIOLET LIGHT EMITTERS

FOR HVAC DUCTS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 – General Requirements and reference documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION OF WORK

A. Provide and install ultraviolet (UV) light arrays and all associated accessories intended for use as part of another manufacturer's air handling unit or mounted in the ductwork as shown on the plans, details, and equipment schedules.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed as recommended by the manufacturer.

C. Certifications:

1. Device shall be certified to comply with all US Environmental Protection Agency's (EPA) FIRFA Act requirements (Note: All manufactured products must be registered and marked with the EPA registration number).
2. Device shall be certified by an NRTL laboratory (UL, ETL, etc.) to meet UL Standards 1598, 153, & 1995; CSA Standard C22.2 No.9-M1989, and UL/CSA harmonized Standard C22.2 No. 236M90 /UL1995.
3. Device shall be certified by manufacturer to achieve a minimum kill rate per air pass for specified control contaminant as noted in the schedule.

    a. Control contaminant to be SARS-CoV-2 (COVID-19).

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for UV light arrays including:

1. Data sheet for each type and configuration of UV light array and accessory furnished; indicating construction, sizes, electrical requirements and mounting details.
2. Product drawings detailing all physical, electrical and control requirements.
3. Statement on the manufacturer's letterhead confirming the specified kill rate of the control contaminant per the schedule.

B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.

B. Store in original cartons and protect from weather and construction work traffic.

C. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.6 WARRANTY

A. Lighting Array structure and all associated accessories shall be warranted against defects in material and workmanship for five years after shipment. UVC lamps shall be warranted by the UVC fixture manufacturer for a period of eighteen months after shipment or 12 months from owner acceptance, whichever is longer. Labor to replace equipment under warranty shall be provided by the installing contractor.

PART 2 - PRODUCTS

2.1 ULTRAVIOLET LIGHT ARRAYS

A. UVC Fixture Manufacturer Requirements:

1. Submit certification data from UL or ETL. Manufacturers without certification shall not be acceptable.
2. Submit EPA registration number as required by the EPA FIFRA Act (7 U.S.C §136 et seq. 1996). Manufacturers without EPA FIFRA registration and proper EPA fixture markings shall not be acceptable.
3. Submit manufacturer's certificate of compliance to required kill rate per air pass of control contaminant.

B. Design Requirement:

1. UVC fixture shall be installed where indicated on the plans in sufficient quantity as to provide distribution of line-of-sight UVC energy to achieve desired minimum kill rate per air pass.
2. When possible, UVC fixtures shall be installed downstream ('wet' side) of cooling coils so as to irradiate coil fins, drain pan, fan motor, and plenum surfaces. Upstream installations are acceptable.
3. UVC fixture shall be sized to provide minimum disinfection of all ventilated air at moving air speeds listed on the equipment schedule; and at air temperatures from 0°C/32°F to 60°C/140°F.
4. UVC fixtures / components (lamps, ballasts, switches, etc.) must be engineered for high-humidity locations. All exposed wiring connectors within the AHU must be liquid tight and NEMA 3R quick-connects and disconnects. All wiring and connectors must be fully encased into a protective metal covering such as EMT, flexible MC cable, or liquid tight/sealtight type flexible conduit. Exposed wiring is prohibited within the AHU. UVC ballasts must be easily accessible for replacement without removal / disassembly of the UVC fixture.
5. UVC fixture mounting structure shall feature tool-less, quick removal of lamp rows for coil /motor maintenance. This feature must be installed in conjunction with quick connect / disconnects.
6. Manufacturer shall provide a lamp-row slide-out option for easy lamp replacement where noted in the schedule. Slide-out option must include electrical quick-connect.

C. UV Light Array General Requirements

1. Device shall be designed and certified for use inside an HVAC system.
2. Device UV Germicidal Lamps shall provide 360^{O} air path disinfection, unless otherwise noted.
3. Device shall include stainless steel lamp clip holders to secure lamp ends and prevent lamp vibration. Device mounting frame shall be constructed from aluminum or stainless steel. No plastics, rubber, or other UV degradable materials; no galvanized, dipped, or painted structures are permitted within the AHU.
4. Device shall self-regulate to operate at all input voltages from 120V through 277V, 50Hz – 60Hz.
5. Device shall be shipped as a complete system with all accessories required to form a complete unit, including door switch, power safety switch, signage, lockouts, reflectors, and other accessories as noted in the schedule.

D. Ultraviolet Lamps:

1. Lamp(s) shall generate peak output at 253.7 nanometers.
2. Manufacturer's data sheets (MSDS) must include lamp data, lamp intensity, and maximum mercury content. Mercury content of the UVC lamp shall be at or below 5mg / lamp (max), and shall be included on MSDS. Lamp(s) shall be "chill-corrected" to generate stated UVC output within air moving at scheduled air velocity on equipment schedule, with air temperature down to 40^{O} F, and

shall generate a minimum average dosage as scheduled. Lamp(s) shall NOT introduce ozone. Limits above UL867-2007 standards shall not be acceptable.

3. Lamp(s) shall be compact, single-ended twin tube design with no external wires in the air path. Lamp life shall be rated at 12 months minimum of service life. Lamp depreciation not to exceed 20% at rated life. Manufacturer shall provide UVC-resistant eye-wear and gloves to facilitate lamp handling during service. Manufacturer shall provide lamp-recycling services and a certificate of lamp recycling in compliance with EPA requirements. All additional costs for collection /recycling services must be included in submittal documents.
4. Provide protective lamp sleeve to prevent accidental lamp breakage in airstream. Light output rating shall include associated de-rate for protective coating and still meet minimum control contaminant kill rate.

E. Ballasts:

1. Ballasts shall have no PCBs, shall be UL and cUL Listed, and specific for the UVC germicidal lamp provided.
2. Electronic ballast shall be listed as 'programmed start', and prioritized in relationship to the UV equipment.
3. Ballasts shall be high power factor, class P, Sound Rating A, Type 1 Outdoor, RoHS compliant.
4. Electronic ballasts shall be "Suitable for Air Handling Spaces" and shall meet the harmonic distortion requirements of ANSI at a minimum operating temperature of –20 degrees F.

F. Safety Features:

1. Device shall employ an integral Safety Interlock Switch for primary access door/panel and all access doors/panel with line of sight to the UV light array to interrupt power to the UV lights when the unit access door is opened. A lockout device is required for each external switch. These door safety switches are to be wired in series.
2. Device shall incorporate signage that meet or exceed UL & OSHA personal safety requirements, and in adequate quantities to provide warnings on all UVC access doors, both primary and secondary.

G. Quality Assurance:

1. The UVC Air Disinfection System shall be a product of an established manufacturer within the USA and shall be made of at least 80% USA sourced raw materials and components. Less than 80% US content is not acceptable.
2. Ozone-generating lamps shall not be used. Max allowable O2 chamber test concentration shall be 0.007 PPM. Peak O2 concentration @ 2 inches from the lamp shall be no more than 0.0042 PPM.

H. Controls:

1. Provide dry contacts for on/off status alarm indication output to the building Energy Management System (EMS).
2. Provide light quantity radiometer sensors, where indicated on the equipment schedule, to measure the light output and associated intensity from the light array. Radiometers shall be factory calibrated and be manufacturer's standard sensor offering. Sensor shall provide 4-20mA or 2-10 VDC measurement output signal to building EMS.

I. Acceptable Manufacturers:

1. Evergreen/Lumalier
2. FreshAire UV
3. UVR

PART 3 - EXECUTION

3.1 DELIVERY & PROTECTION

A. Deliver all equipment to the site as indicated in Division 1.

B. Contractor to perform installation and start-up to include installation of all accessories as required to make a complete and operating system.

C. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost to the Owner.

3.2 UV LIGHT ARRAY INSTALLATION

A. Coordinate the electrical services and control wiring with the Electrical Systems Installer. The manufacturer of each item of equipment shall provide complete wiring diagrams to the Electrical Systems Installer and shall provide drawings indicating all required external wiring and arrangement of all field connections.

B. UVC Equipment installation must provide simple access in such a way that routine maintenance and lamp change shall be performed without UV fixture disassembly and without the use of tools.

C. Contractor must install only UVC products properly marked with EPA registration numbers.

3.3 COMMISSIONING & TRAINING

A. Manufacturer must provide installation instructions and commissioning assistance, including training, parts manuals, maintenance and technical assistance, and safety information to help maintain the UVC system at peak operational efficiency.

END OF SECTION

SECTION 23 05 93

MECHANICAL SYSTEMS TESTING, ADJUSTING, AND BALANCING (TAB)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section shall be related to the General Provisions of the contract, including General and supplementary conditions.

B. Refer to Section 23 05 00 for general provisions.

1.2 SCOPE OF WORK

A. The work included in this Section consists of the furnishing of all labor, instruments, tools and services required in connection with the Testing, Adjusting and Balancing (TAB) of the Heating, Ventilating and Air Conditioning (HVAC) systems as described in the mechanical specifications and shown on the mechanical Drawings, or reasonably implied therefrom, to include the overall commissioning of systems and subsystems such as verification of operation of each control device and all equipment sequences of operation.

B. TAB of the HVAC systems will be performed by an impartial independent Technical Firm who is a member of the Associated Air Balance Council (AABC) and whose operations are limited only to the field of professional TAB work. TAB Services shall be contracted directly by General Contractor. TAB firm shall be one of the following:

   a. Engineered Air Balance.
   b. Delta T.
   c. Air Balance Company.

C. TAB Firm is responsible to and shall submit all reports directly to the Architect/Engineer and as requested to the Owner.

D. TAB services shall result in the optimum temperature, humidity, airflow, pressurization, ventilation rates, and noise levels in the conditioned spaces of the building.

E. The following basic components of the HVAC systems shall be tested, adjusted and balanced:

   1. Air distribution systems.
   2. Air moving equipment.
   3. Pumping systems (chilled water, heating water, hot water, etc.).
   4. Cooling systems.
   5. Heating systems.
   6. HVAC control systems verification to include end devices, control sequences of operation and energy management system control and monitoring point verification.

F. Document Review

   1. The TAB Firm shall be responsible for reviewing the HVAC Drawings and specifications relating to the TAB services for proper arrangement and adequate provisions of devices for testing, adjusting and balancing.
   2. TAB Firm shall review HVAC manufacturer's submittal data relative to suitable provisions to allow system to be balanced
   3. TAB Firm shall review submitted HVAC automatic temperature control sequences for conformity to the specifications.

G. Three (3) hard bound copies and three (3) .PDF file copies saved onto USB drives of final report shall be submitted to the owner, or representative thereof, indicating a summary of actual operating data and any

abnormal operating conditions. The report will contain all required information as described within this specification. The files shall also include copies of HVAC drawings annotated to reflect tags used for air and water components balanced.

1.3 SERVICES OF CONTRACTOR

A. Contractor shall start up and test all materials and equipment which normally require testing. All piping, ductwork, etc., shall be tested to meet code requirements and the specification requirements, whichever is the more stringent. All equipment shall operate a sufficient length of time at the Contractor's expense to prove to the Architect, Engineer, and Owner that the equipment is free from mechanical defects, runs smoothly and quietly and performs satisfactorily to meet the requirements set forth in the Mechanical Drawings and Specifications.

B. In order that all HVAC (and domestic hot water central thermostatic mixing valves and recirculating pump) systems can be properly tested, adjusted and balanced, the Contractor shall operate the HVAC systems at their expense for the length of time necessary to properly verify their completion and readiness for TAB, and shall further operate and pay all costs of operation during the TAB period if not otherwise specifically addressed to be paid by the Owner. Operating expenses to be paid for by the Contractor (not TAB firm) will include, where applicable, but not necessarily be limited to, the following:

1. Utility costs; electrical, water, gas, etc., as applicable.
2. Personnel costs to start, operate and stop all HVAC equipment.
3. All start-up labor and materials costs.
4. All maintenance costs.
5. Water treatment.

C. The drawings and specifications have indicated valves, dampers and miscellaneous adjustment devices for the purpose of testing, adjusting and balancing the HVAC systems to obtain optimum operating conditions. It will be the responsibility of the Contractor to install these devices in a manner that will leave them fully accessible and readily adjustable to include access to allow recording of all motor and fan nameplate data. The TAB firm shall be consulted if there is a questionable arrangement of a control or adjustable device. Should any such device not be readily accessible, the Contractor shall provide access as required by the TAB firm.

D. Contractor shall provide and coordinate the services of qualified, responsible sub-contractors, suppliers, and personnel as required to correct, repair or replace any and all deficient items or conditions found before and during the TAB period.

E. As a part of this Project Contract, the Contractor shall make any changes in the sheaves, belts, motors, dampers and valves, or the addition of dampers and valves as required, to correctly balance the HVAC systems as required by the TAB firm at no additional cost.

F. Provide sufficient time in Project Contract completion schedule to permit the completion of TAB services prior to Owner occupancy of the project.

G. Contractor shall furnish, without charge to the TAB Firm, the following (Digital and Hard Copies):

1. One (1) complete set of project specifications to include all mechanical sections.
2. One (1) complete set of Contract Drawings.
3. All pertinent change orders and all Addenda.
4. Two (2) complete sets of mechanical plans with latest revisions.
5. Any "As-installed" and shop drawings.
6. Approved HVAC system control diagrams.
7. Approved manufacturer's submittals for all HVAC equipment to be included in the TAB scope of work.

H. Have all HVAC systems complete and in operational readiness prior to notifying the TAB Firm that the project is ready for TAB services. So certify in writing to the Architect, Engineer, and Owner that such a

condition exists. Complete operational readiness prior to commencement of TAB Services shall include the following:

1. Construction status of building shall permit the closing of doors and windows, ceilings installed, etc., to permit the obtaining of projected actual operating conditions. Preliminary air testing may be conducted without ceiling tiles and completion of the facility. However, final air testing requires that ceilings be completely installed so that air pressurization relationships can be properly verified.
2. Air Distribution Systems:
    a. Verify installation for conformity to design of all supply, return and exhaust ducts. Document and certify that all duct leakage tests as required by the mechanical specifications have been performed and the test results are within specified limits (provide copies of leakage test results). TAB firm shall be notified of the time when all leakage tests are to be conducted to allow them to witness as needed.
    b. Verify that all volume dampers, smoke dampers and fire dampers are properly located, functional and open; verify that properly located, sized, and labeled access doors are installed in ducts and in general construction (ceilings, walls, furrings, etc.).
        1) Contractor shall manually release the fire, smoke or fire-smoke damper which shall be witnessed by the TAB firm or local municipality representative; to observe the full opening and closing of the dampers. Document these witness tests in writing.
        2) Contractor shall open or reset fusible links on these dampers, as required.
        3) Contractor shall furnish tags at each damper for recording the date, time and individual who last verified the operation of each damper.
    c. Verify that minimum outside air, maximum outside air, return air and relief air dampers provide tight closure, open fully and operate smoothly and freely.
    d. Verify that all supply, return, exhaust and transfer air diffusers, grilles and registers are installed as indicated on the mechanical Drawings.
    e. Verify that the correct size and type of terminal boxes are installed as indicated on the mechanical Drawings, and that they are fully operational.
    f. Verify that all built-up type air handling systems, air handling units, etc. and associated apparatus such as heating coils, cooling coils, filter sections, access doors, etc., have been blanked and sealed to eliminate the bypass of air around the coils, filters, etc. or leakage of air into or out of the unit.
    g. Install the specified type and quantity of clean filters at each air handling unit and maintain these filters for the complete period that the subject system is being tested, adjusted, and balanced. Refer to Section 23 30 00. New filters shall be installed just before air balance work is performed to insure clean filters are the basis of the test data provided.
    h. Verify that all (supply, return, relief and exhaust) fans are operational including proper fan rotation, operates free from vibrations, belts are properly aligned, and belt tension is proper.
    i. Verify that all motor starter overload heater elements are of proper size and rating; nameplate amperage to be within the range of the heater element size.
    j. Make a record of actual motor amperage and voltage, for each phase, and verify that they do not exceed nameplate ratings.
    k. Verify specified vibration isolation accessories are correctly installed and adjusted.
    l. Insure that all fan drive components, motors, belts, sheaves, and fan wheels are all accessible to allow for servicing and verification of name plate data, sizes, and model and serial numbers, as applicable.
    m. Provide additional air balance dampers, water balance valves, and replacement sheaves and belts as required to successfully complete TAB work.
    n. Flag all air balance dampers with flourescent, or other high visibility tape, leaving a minimum of one inch (1") wide by three inches (3") long exposed to view.

I. Water Circulating Systems:

1. Check and verify pump alignment and rotation.

2. All water circulating systems shall be filled until full of water and purged to be free of air; expansion tanks set for proper water level; systems set to proper operating pressure; air vents installed at all high points of systems and operating free of air.
3. Open all valves to full open position. Set automatic control valves to full flow through system coils or components and close off bypasses at 3-way valves. Flush and clean systems as specified in other sections of the mechanical specifications (with full flow through all coils). Circulate clean water through system for a sufficient time to verify flow through all system components. Remove and clean all strainers. Repeat operation until circulating water systems are clean.
4. Verify that all motor starter overload heater elements are of proper size and rating; nameplate amperage to be within the range of the heater element size.
5. Make a record of actual motor amperage and voltage, per phase, for each pump and verify that they do not exceed nameplate ratings.
6. Verify specified vibration isolation accessories are correctly installed and adjusted.
7. For domestic water systems, include start-up, checkout and verification, of all thermostatic mixing valves and operation thereof.

J. Refrigeration Machines:

1. Verity that the specified start-up and check-out of the refrigeration machines was accomplished by approved representatives of the machine manufacturer, and that all necessary adjustments have been made in conformance with recommendations thereof.
2. Verify that electrical circuits, control and power, have been properly and permanently installed and connected, with circuit protective devices correctly sized and calibrated.
3. Verify that specified vibration isolation accessories are correctly installed and correctly adjusted.
4. Record the voltage and amperage at each motor, per phase, and verify that name plate values are not exceeded.

K. Boilers:

1. Verify that specified start-up and check-out of each boiler was accomplished by approved representatives of the equipment manufacturer, and that necessary adjustments have been made in conformance with recommendations thereof.
2. Verify that electrical circuits, control and power, have been properly and permanently installed and connected, with circuit protective devices correctly sized and calibrated.
3. Verify that specified vibration isolation accessories are correctly installed and adjusted.
4. Record the voltage and amperage at each heating element and each motor, per phase, and verify that name plate values are not exceeded
5. Verify that all piping connections have been made in accordance with the manufacturer's recommendations, and specification and drawing requirements.
6. Verify that flue gas vent piping has been correctly installed in accordance with the boiler manufacturer's recommendations and these specifications. Verify that the proper draft has been achieved for each boiler burner system.

L. Automatic Controls:

1. Verify that all control components are installed in accordance with project requirements and are functional as intended by these specifications, including all electrical interlocks, damper and valve sequences, air and water temperature resets, duct smoke detectors, high limit pressure sensors, freezestats, safeties, etc.
2. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats which shall be calibrated at the completion of TAB services in full cooperation between TAB Firm and controls system installer.
3. Automatic temperature control and/or energy management system installer shall thoroughly check all controls, sensors operators, sequences of operation, etc. before notifying the TAB agency that the automatic temperature controls and energy management system are operational. Automatic temperature control and/or energy management system installer shall provide technical support staff (technicians and necessary hardware and software) to the TAB agency to allow for a complete check out of these systems; controls personnel to be on site with TAB firm as needed to assist the TAB firm in completing the TAB work.
4. The controls system installer shall also provide trending reports with the specific points and trend intervals, as requested by the TAB firm or engineer, when abnormal conditions are experienced.
5. The scope of the TAB work, as defined herein, is indicated in order that the contractor will be apprised of their responsibility regarding the coordination and assistance required to complete the

project requirements for final TAB. The TAB Firm will be responsible to the Architect, Engineer, and Owner for the satisfactory execution of the TAB services.

1.4 SERVICES OF THE TAB FIRM

A. TAB Firm Qualifications:

1. TAB Firm shall be one which is organized to provide independent professional testing, adjusting and balancing services. The firm shall have one (1) Professional Engineer licensed in the State of Texas, with current registration, on their staff. TAB Firm shall have operated a minimum of ten (10) years, under its current firm name.
2. All personnel used on the job site shall be either TAB engineers or TAB technicians, who shall have been permanent, full-time employees of the Firm for a minimum of one (1) year prior to working on this specific project.
3. TAB Firm shall submit the following to the Architect/Engineer and/or Owner for approval prior to commencing services:

    a. Name and biographical data of the firms Professional Engineer and all other key personnel to be assigned to this project.
    b. Proof of company operation for a minimum of ten (10) years.
    c. Current AABC certification.
    d. Documentation of number of full time staff size, specifically those personnel who perform or supervise the performance of TAB work.

B. TAB Firm Responsibilities:

1. Liaison: The TAB personnel on the job shall act as liaison between the Architect, Engineer, Owner and Contractor.
2. Inspect the installation of mechanical piping systems, sheet metal work, temperature controls and other component parts of the HVAC systems during the early construction stages, and at other appropriate stages, for the purpose of reviewing that part of the work relating to proper arrangement and adequate provisions for TAB.
3. When performing inspection services prepare a punch list to be copied to the Architect, Engineer and Contractor noting observed deficiencies that would prevent adequate access to equipment and components installed or missing that would prevent the TAB Services from being carried out successfully.
4. Witness the first duct static pressure test performed on duct systems rated over 3.0 Inches W.G. to verify proper testing procedures are followed and documented. Include time for witnessing approximately 20% of all tests performed. Should the initial testing be unsatisfactory, then witnessing of the retest will be required. Document tests witnessed in writing.

C. TAB Firm Services:

1. TAB personnel shall, upon completion of the installation and start-up of the mechanical equipment systems, test, adjust and balance the HVAC systems to provide optimum temperature, airflow and noise conditions in the conditioned spaces in the building while the HVAC equipment is operating efficiently.
2. The Firm shall be responsible for testing, adjusting, balancing and logging actual data on all air distribution and air moving equipment, water distribution and water circulating equipment, fans, pumps, heating and cooling equipment and the operating conditions of all motors, etc. as indicated in this specification.

    a. Air Handling Units and Fan coil Units:

        1) Verify that the outside, return and relief air dampers are installed correctly, are fully operational and move freely.
        2) Verify that filters are new and clean, to include being the specified type, thickness and efficiency specified, at the time testing is performed.
        3) Verify correct fan rotation (supply and return fans).
        4) If belt driven, verify proper belt tension and that fan and motor sheaves are properly aligned.
        5) Verify that all AHU safeties are operational (freezestat, high static pressure, etc.)

6) If applicable, verify that VAV air handling unit volume control (static pressure) is operational. Set fan volume control device for 100% capacity (with terminal boxes set at 100% capacity or equal to the diversity factor applicable to the system).
7) Verify correct size and rating of motor overload protection (all phases as applicable).
8) Verify fan motor is not overloaded; amperage readings do not exceed motor nameplate rating.
9) Determine total supply and return air. Air quantities to be determined by duct traverse if duct configuration permits and air velocity is 800 to 1000 feet per minute or greater. If the duct main is not suitable for traverse then traverse branch ducts as required to total air flows supplied by the system.
10) Balance air distribution system (see Terminal Boxes and Air Distribution Devices.)
11) If total air volume is less than design and motor capacity is available, adjust fan or fans and drives, as needed, to obtain supply and return design CFM quantities to within + 10% of design. If new sheave or sheaves and belts are required, data will be submitted to Contractor for change out thereby. Then retest system to obtain design air quantities. Motors should be fully loaded if required to meet the tolerances specified herein.
12) If applicable, determine the required static pressure and submit the static pressure control set point to control contractor for setting. Final set point shall not be arbitrary, but shall be based on the minimum value to obtain design air flows at 100% operation (Account for diversity as required).
13) Test and adjust the minimum outside air quantity up to any maximum values scheduled, for demand controlled ventilation, economizer operation and return air CFM relationship to design.
14) Where air flow meters are installed verify flow rates through air flow measuring components.
15) Balance overall air distribution system (see air distribution devices).
16) Verify all temperature control devices are set and calibrated at design set point. Document sensor values as compared to a calibrated temperature test instrument and further record Energy Management System offsets programmed to obtain calibration requirements specified herein.

b. Terminal Boxes:

1) Determine sequence of operation from the specification and verify that all control devices are installed and fully operational.
2) Set primary air volumes (minimum and maximum) for cooling.
3) Set primary air volume for heating mode for single duct VAV terminals, typical for water heating coils (no fan).
4) Adjust fan volume to scheduled air flow for parallel and series flow fans.
5) Balance air distribution system (see Air Distribution Devices).
6) Test capacity of heating devices, as applicable, by measuring entering and leaving air temperatures (refer to water and electric heating coils).
7) Test and verify box sequence of operation to ensure specified control sequence is achieved.
8) Check calibration of temperature sensors. Program offsets as required to reach specified tolerances. Document sensor values as compared to a calibrated temperature test instrument and further record Energy Management System offsets programmed to obtain calibration requirements specified herein.

c. Air Distribution Devices:

1) Preset all volume dampers in the 100% open position.
2) Determine and verify proper air pattern deflection devices have been installed.
3) Verify size and types of all air devices installed, versus, the sizes and types indicated on the Drawings, to include neck sizes of diffusers.

4) Read out all air distribution devices served by their source (VAV Terminal, FPB Terminal, Fan Coil Unit, Constant Volume Air Handling Unit, Supply Fan, Exhaust Fan, etc.)
5) Balance all air distribution devices proportional to design CFM.
6) Adjust source to design CFM.
7) Verify that all air distribution devices are balanced to within plus or minus 10% of design (and all proportional to one another, + 10% from high to low, on each system even if the total can not be within 10% of design).
8) Tolerances for 100% outside air ducts and outside air introduced through air handling equipment shall be +5% to -10%.

d. Supply, Exhaust and Relief Fans:

1) Verify correct fan rotation.
2) If belt driven, verify proper belt tension and that fan and motor sheaves are properly aligned.
3) Verify that all safeties and interlocks are operational.
4) Verify correct size and rating of motor overload protection.
5) Verify fan motor is not overloaded; amperage readings do not exceed nameplate rating, for each phase, as applicable.
6) Determine total air quantities of system served by the respective fan. Air quantities to be determined by duct traverse if duct configuration permits and air velocity is 800 to1000 feet per minute or greater. If the duct main is not suitable for traverse then traverse branch ducts as required to total air flows supplied by the system.
7) If air volume is less than design and motor capacity is available, adjust fan to design CFM. If new sheave or sheaves and belts are required, data will be submitted to Contractor.
8) Witness positive pressure duct leakage tests performed by the contractor on large exhaust systems to minimize duct leakage in these systems.
9) Balance air distribution system (see Air Distribution Devices).

e. Fire, Fire-Smoke, and Smoke Dampers:

1) Verify operation of all fire-smoke and smoke dampers only by witnessing the Contractor fully opening and closing these dampers.
2) Verify each fire, fire-smoke, and smoke damper is located where indicated on the Drawings and tagged or identified with a permanent fire resistant tag or stencil (at access door location).
3) Verify that each fire, fire-smoke, and smoke damper is provided with a suitably sized and located access door to allow full testing and observation of damper operation. Verify each duct access damper has suitable access through general construction features.
4) Witness the Contractor testing each fire-smoke and smoke damper which shall be manually released, allowed to fully close, verifying it has a tight fit when closed, and then verify it does not bind when opening or closing.
5) Witness each fire-smoke and smoke damper being fully opened by the Contractor and the fusible links on the fire damper portion of fire-smoke dampers being reset by the Contractor to include other related devices on smoke-fire dampers.
6) Verify that all fire dampers are fully opened.
7) Identify all dampers requiring repair or having a faulty installation.
8) Write down pertinent information on damper testing tags to verify dates tested and initials of tester to confirm a successful test was conducted.

f. Pumps:

1) At the time the contractor removes the start-up strainers, verify (by witnessing) that they are clean and are of the proper type. Verify the specified final strainers are clean and installed.
2) Verify correct pump rotation.
3) Verify correct sizing of each motor overload protection device.
4) Verify pump motors are not overloaded; amperage readings do not exceed motor nameplate rating for all phases.
5) Preset all manual isolation and balance valves at pumps and heat transfer devices to 100% open position.
6) Set all automatic control valves to 100% flow position. Verify valve design water flow rates match approved equipment submittal flow rates (must be balanced within +10% of design/submittal flow rate).
7) Determine total GPM by measuring actual pumping head of pump and relate to manufacturer's curves.
8) Measure actual pressure drop at each heat transfer device and flow metering device, if applicable.
9) Proportionally balance all heat transfer devices to within + 10% of design GPM by adjusting balancing valves. Overall total flow rate shall also be balanced to within +10% of total design.
10) If GPM is above design and the mechanical specifications indicate the pump impellers are to be trimmed to provide design GPM, data will be furnished to the Contractor so that they can trim the impeller or impellers, as required. If not, discharge balancing valve at each pump will be adjusted as required to obtain design GPM as related to the manufacturer's curves (with variable frequency drives set at 60 Hertz, where applicable).
11) Verify all temperature control devices are set and calibrated at design set point.
12) Verify all interlocks and flow switches are installed and operating properly to include minimum differential set points for differential pressure type flow switches.
13) Test and record all entering and leaving air and water temperatures and pressures at all heat transfer devices, as applicable. Refer to individual heat transfer device and cooling and heating coil data requirements.

g. Refrigeration Machines (Chillers): Take and record the following readings on each refrigeration machine (readings shall be taken as nearly simultaneously as possible). Readings on refrigeration machines shall be taken from gauges or indicating devices supplied with the machines. Readings shall not be taken on components that would void machine warranty. Manufacturer's authorized representative shall be present to assist in taking readings.

1) Evaporator:

a) Entering and leaving water pressures.
b) Water pressure drop.
c) Entering and leaving water temperatures.
d) Water temperature drop.
e) GPM through evaporator (may be obtained from pump GPM).

2) Compressor:

a) Make/model/serial number.
b) Voltage (T1-T2, T2-T3, T3-T1).
c) Amperes (T1, T2, T3).
d) Chilled water control setting.
e) Low temperature cut-out setting.

3) General:

a) Scheduled capacity.
b) Refrigerant type.
c) Starter manufacturer, size, and type.
d) Overload heater sizes.
e) Low temperature safety cut-out setting.
f) Demand limit set-point.

4) All the above tests shall be conducted at full load, and at each of the part-load conditions listed elsewhere in other Sections of these Specifications.

h. Boilers: Take and record the following readings on each boiler (readings shall be taken as nearly simultaneously as possible). Boilers shall be tested with the manufacturer's representative present. Readings shall not be taken on components such that manufacturer's warranty would be voided.

1) Manufacturer/model/serial number.
2) Energy source - type fuel(s).
3) Capacity ratings, input and output.
4) Hot water system working pressure.
5) List electrical loads, with name plate, versus actual electrical characteristics for each motor (Volts and Current, per Phase).
6) Check water level controls (feeders and low water cut-offs).
7) Check operation of operating and limit controls (hot water cut-out temperature).
8) Check safety valves for conformance to boiler manufacturer's recommendations, and for settings.
9) Verify operation and correct setting of each differential pressure flow proving switch.

i. Heat Exchangers, Cooling and Heating Coils, and Energy Recovery components:

1) Verify that all water connections, valves, and accessories are installed per the design documents, as applicable.
2) Verify that all coils and heat exchangers are installed properly.
3) Verify that all cooling and heating coils have filters installed upstream of coils.
4) Verify all water control valves fully open and close. Verify no simultaneous cooling and heating occurs at any piece of equipment except during a humidity control sequence.
5) Verify correct overload devices are installed for electric heating devices.
6) Verify operation of all safety devices.
7) Record entering and leaving water pressures, as applicable, to determine actual water pressure drop as compared to the design value. Adjust readings for variation in test instrumentation elevation difference where instrument is not maintained at the same elevation when testing a specific piece of equipment.
8) Record entering and leaving water temperatures, as applicable, to determine actual water temperature drop as compared to the design value.
9) Record entering and leaving air dry bulb temperatures, as applicable, to determine actual air temperature drop or rise as compared to the design value for all equipment tested. Additionally, for cooling coils and energy recovery equipment with latent capabilities, record the entering and leaving wet bulb temperatures for each component.

j. Rooftop Air Conditioning Units (RTU):

1) Verify that the outside, return and relief air dampers are operational and move freely.
2) Verify that filters are new and clean at the time of testing.
3) Verify correct evaporator and return or relief air (as applicable) fan rotation.
4) If belt driven, verify proper belt tension and that fan and motor sheaves are properly aligned. If direct drive, verify that motor is a multi-speed motor and adjust speed setting

for air balance purposes unless a single speed fan is used in conjunction with a variable frequency drive.

5) Verify that all equipment safeties are operational, as applicable, (low and high pressure limit switches, freezestat, high static pressure, anti-recycle timer, etc.).
6) If applicable, verify that unit air volume control (static pressure) on VAV type units is operational. Set fan volume control device for 100% capacity (terminal boxes set at 100% capacity). Set point shall be slightly higher than the minimum pressure required to obtain design air flow at all terminals.
7) Verify correct size and rating of motor overload protection for each supply, return and relief fan motor.
8) Verify each fan motor above is not overloaded; amperage readings do not exceed motor nameplate rating.
9) Determine total supply and return air. Air quantities to be determined by duct traverse if duct configuration permits and air velocity is 800-1000 feet per minute or greater.
10) Balance air distribution system (see Air Distribution Devices).
11) If air volume is less than design and motor capacity is available, adjust fan or fans, to obtain supply and return design CFM quantities to within + 10% of design. If new sheave or sheaves and belts are required, data will be submitted to Contractor for change out. For direct drive fans, adjust fan speed setting. For fans served by variable frequency drives record fan speed and drive hertz at 100% design air flow. After adjustments are made, retest units to determine final air balance quantities.
12) Test and adjust the minimum outside air up to any maximum values scheduled, for demand controlled ventilation, and return air CFM relationship to design.
13) Verify all temperature control devices are set and calibrated at design set points. Document sensor values as compared to a calibrated temperature test instrument and further record Energy Management System offsets programmed to obtain calibration requirements specified herein.

3. During the balancing process, all abnormalities or malfunctions of equipment or components discovered by the TAB personnel, will be reported promptly to the Architect, Engineer, Owner and Contractor so that the condition can be corrected expediently.
4. The temperature controls will be verified for calibration and proper relationship between control devices. The Contractor will be advised of any instruments out of calibration so that the Automatic Temperature Controls (ATC) contractor can recalibrate, using data supplied by the TAB Firm as required.
5. Thoroughly test the Energy Management System (EMS), as applicable. The testing of the Energy Management System shall include all HVAC controls, sensors, operators, sequences, etc. The tests shall include verification that commands introduced at the EMS console actually occur and temperatures, pressures, etc. indicated at the EMS console correlate with the actual reading at the sensing point. The ATC and EMS contractor shall provide technical support to the TAB Firm for a complete check out of the HVAC temperature controls and the Energy Management System. The EMS workstation console and field direct digital control panel displays of measured variables such as temperature, relative humidity, and pressure shall have the displayed values offset through software to be within 0.3 Deg.F. of the temperature, 5.0 percent for relative humidity, 20 parts per million (ppm) for carbon dioxide, 10 parts per million (ppm) for carbon monoxide and 0.01% for pressure of the actual variables measured in the field, with recently calibrated test equipment, at the sensor locations.
6. After testing, adjusting and balancing to the design conditions, if comfort conditions are not being maintained, the air conditioning system shall be rebalanced within the limitations of the equipment installed to obtain comfort conditions. If comfort conditions cannot be obtained, a report will be submitted giving specific data regarding the trouble area.
7. Make not less than three (3) inspections within ninety (90) days after occupancy of the building, and make adjustments if required, to insure that satisfactory conditions are being maintained throughout. Inspections are to be coordinated with Architect, Engineer, and Owner; and shall be documented with a supplemental report containing data and information, as required, after each visit, to document in writing that such visit took place and to note any unusual operating conditions.
8. Make an inspection during the opposite season from that in which the initial adjustments were made and at that time make any necessary modifications to the initial adjustments required to produce

optimum operation of the systemic components to produce the proper conditions in each conditioned space. The opposite season inspection shall be coordinated with the Architect/Engineer and Owner. This inspection shall be documented with a supplemental report containing any pertinent data and information regarding readings and adjustments made.

9. Include testing and verification of domestic water centralized thermostatic mixing valves where connected to a pumped re-circulating system as well as TAB on the associated pumps and water balance stations on each separate system.

1.5 TAB REPORT

A. TAB report shall incorporate all performance data for the HVAC systems. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operating personnel.

B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must be made on site by the permanently employed technicians or engineers of the TAB Firm.

C. TAB report shall include but not be limited to the following:

1. Index.
2. Preface: A general discussion of the system, an outline of normal and ventilation modes of operation, any unusual operating conditions and any deficiencies not corrected as of the time the report was written.
3. Instrumentation List: A list of instruments used by type, model, range and calibration date. All instruments must be calibrated within six (6) months prior to the starting date of TAB services. Test probes used in domestic water system testing shall be sterilized before being used in these systems.
4. Air Handling Units, Fan Coil Units, etc.:
    a. Manufacturer, model, size and serial number.
    b. Design and actual CFM (Supply, Return and Outside).
    c. Design and actual fan RPM.
    d. Static pressure entering and leaving each filter bank, all coils and fans and other heat transfer components such as energy recovery wheels.
    e. All motor nameplate data.
    f. Motor starter data and motor overload protection (heater) sizes and rating for each motor.
    g. Actual motor amperage and voltage (all phases) as compared to the nameplate data.
    h. Filters; type, thickness, sizes, manufacturer, model number, MERV rating, quantities of each size and condition (new, clean, dirty, wet, etc.).
5. Terminal Boxes:
    a. Manufacturer, model and size.
    b. Location.
    c. Design and actual primary air cooling CFM (maximum and minimum).
    d. Design and actual primary air heating CFM, where applicable (single duct reheat terminals).
    e. Design and actual fan CFM, if applicable (fan powered terminals).
    f. Actual entering and leaving air temperatures at hot water coils, as applicable.
    g. Actual entering and leaving air pressures (pressure drop) at hot water coils.
    h. Actual entering and leaving air pressures (pressure drop) at each hot water coil filters.
    i. Filters; type, thickness, sizes, manufacturer, model number, MERV rating, quantities of each size and condition (new, clean, dirty, wet, etc.).
6. Air Distribution Devices (Supply, Exhaust, Return, and Relief Air type where Balance Dampers are used):
    a. Manufacturer, model and size; include neck sizes for diffusers.
    b. Location (Room name and number, ceiling, wall, etc.).
    c. Design and actual CFM (cooling and heating).

d. Air distribution devices, where a velocity indicating instrument is used to determine CFM; provide the required and actual velocity in FPM (when an air flow hood is used to determine CFM, only CFM is required to be recorded.)

7. Supply/Exhaust Fans:

a. Manufacturer, model and size; include neck size where different than the designated device size.
b. Location (Room name and number, above ceiling, roof mounted, etc.).
c. Design and actual CFM.
d. Design and actual fan RPM.
e. Design and actual static pressure (leaving minus entering).
f. Motor nameplate data.
g. Motor starter data and motor overload protection (heater) sizes and rating.
h. Actual motor amperage and voltage (all phases).

8. Fire, Fire-Smoke, and Smoke Dampers:

a. Fill out a tag (provided by the Contractor) at each damper with a set of the tester's initials and the date that the damper was tested and operation verified, as witnessed by the TAB firm, as being acceptable.
b. Tags shall have additional spaces for future testing/verification.

9. Water Coils and Heat Exchangers:

a. Manufacturer, model, size and serial number where available.
b. Design and actual CFM (to include purge CFM for Energy Wheels).
c. Design and actual entering and leaving air static pressures.
d. Design and actual entering air dry bulb temperatures. Provide design and actual entering air wet bulb temperatures for each cooling coil and latent energy recovery component.
e. Design and actual leaving air dry bulb temperatures. Provide design and actual leaving air wet bulb temperatures for each cooling coil and latent energy recovery component.
f. Actual outside air temperature, dry and wet bulb, during testing.
g. Design and actual entering water temperature.
h. Design and actual leaving water temperature.
i. Design and actual water coil pressure drop (entering and leaving pressures).
j. Design and actual water flow rate, GPM.

10. Pumps:

a. Manufacturer, model, size and serial number.
b. Design and estimated impeller size from manufacturers pump curves (obtained through shut-off head test).
c. Actual pump suction and discharge pressures.
d. Design and actual pumping head.
e. Design and actual GPM.
f. Motor nameplate data.
g. Motor starter data and motor overload protection (heater) sizes and rating.
h. Actual motor amperage and voltage (all phases).

11. Chillers:

a. Manufacturer, model, size and serial number.
b. Rated tonnage.
c. Design and actual chilled water pressure drop (entering and leaving pressures).
d. Design and actual chilled water flow rate, GPM.
e. Design and actual entering and leaving chilled water temperature at 100% load.

12. Boilers:
    a. Manufacturer, Model, size and serial number.
    b. Fuel Type (natural gas, No. 2 fuel oil, etc.)
    c. Rated Capacity:
    d. Input-MBH.
    e. Output-MBH.
    f. Design and actual water flow rate, GPM
    g. Design and actual entering and leaving water pressures, to include total water pressure drop, ft. of water, or PSI.
    h. Design and actual entering and leaving water temperature at high fire under full load.
13. Split System Indoor Units:
    a. Manufacturer, Model, Size, and Serial Number.
    b. Design and actual CFM (supply, return, and outside air).
    c. Design and actual evaporator motor RPM.
    d. Static pressure entering and leaving filters, coils, furnaces, and fans.
    e. Evaporator motor name plate data.
    f. Evaporator motor starter data and motor overload protection size and rating, or setting, for adjustable devices.
    g. Actual evaporator motor amperage and voltage (all phases).
    h. Filters; type, thickness, sizes, quantities of each size, and condition (new, clean, dirty, loaded, wet, etc.).
14. Condensing Units:
    a. Manufacturer, Model, Size, and Serial Number.
    b. Location.
    c. Actual unit name plate data.
    d. Actual unit (compressor and condenser unit motors) amperage and voltage, all phases.
    e. Ambient air temperature entering condenser during indoor and outdoor unit testing.
15. Rooftop Air Conditioning Units:
    a. Manufacturer, model, size and serial number.
    b. Design and actual CFM (Supply, Return and Outside Air).
    c. Design and actual Evaporator Fan RPM.
    d. Static air pressure entering and leaving filters, coils, heaters, control dampers, and evaporator fan.
    e. Evaporator, Return and Relief Air (as applicable) motor nameplate data.
    f. Evaporator, Return and Relief Air (as applicable) fan motor starter data and motor overload protection heater sizes and rating (for each phase).
    g. Actual evaporator motor amperage and voltage (all phases).
    h. Filters; type, manufacturer, model, MERV rating, thickness, sizes, quantities of each size, actual static pressure drop across filters and condition (new, clean, dirty, loaded, wet, etc.).
    i. Total unit Nameplate data (Volts, Amps, and overcurrent protection required).
    j. Actual Unit volts and amps, for each phase, and actual overcurrent protection device rating, with the unit operating in full cooling.
    k. Actual outside air temperature, dry and wet bulb (or relative humidity) during testing.
    l. Condenser coil entering and leaving air dry bulb temperatures at full cooling.

D. Instructions to Operating Personnel: TAB Firm shall instruct the operating personnel regarding the following:
    1. Systems Operation.
    2. Unusual Operating Conditions
    3. System Troubleshooting Procedures.

E. Guarantee: Provide extended warranty of twelve (12) months after occupancy during which time the Architect/Engineer and/or Owner may, at his discretion, request check of the balance of any HVAC equipment. Provide TAB technicians to assist as required in making such tests. When any device is found not balanced in accordance with the mechanical plans and specifications, that HVAC system shall be completely rebalanced as directed by the Architect/Engineer and/or Owner at the TAB Firm's expense.

END OF SECTION

SECTION 23 07 00

INSULATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. Provide the systems of insulation which are specified for the control of heat transfer, sound control, and prevention of condensation.

B. Provide protective devices to prevent compression abrasion or puncture of the piping insulation systems installed to include inserts, pipe shields, PVC jacketing and aluminum jacketing as specified herein.

C. Provide piping identification systems as specified in Section 23 05 53, Mechanical Systems Identification for HVAC ductwork, equipment and piping.

D. Provide heat tracing as specified in Section 23 05 33, Heat Tracing for HVAC piping.

1.3 QUALITY ASSURANCE

A. The installation of all thermal insulation shall be performed by a single firm regularly engaged in the insulation business, using skilled insulation mechanics and using insulation materials which are the product of reputable manufacturers. The application of the materials by the insulator shall be in accordance with the published standards of the manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

B. Materials shall be manufactured by Schuller, Pittsburg Plate Glass, Owens-Corning, Foster, Childers, Certainteed, Johns Manville, or Knauf.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions to allow review of Materials and Methods to ensure complete compliance with specifications.

B. Shop Drawings: Submit materials to be used and method of application for each system in tabular form. General statements not specifically identifying means or methods to be used shall be cause for rejection. Include descriptive data and cut sheets on each type of insulation material, sealing method, adhesives used, insert types, shield sizes, and PVC or aluminum jacketing as specified.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Promptly replace all damaged, deteriorated or wet insulation materials.

C. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 PIPING AND EQUIPMENT INSULATION MATERIALS

A. Chilled and Heating Water Supply and Return Piping Insulation:

1. Insulation shall be approximately 4 lb. or heavier in density, molded sectional glass fiber pipe covering with factory applied, white FRG, fire resistant, vapor barrier jacket.
2. Insulate valves and fittings with pre-molded glass fiber fitting pipe insulators with ASJ manufactured by Knauf, Owens-Corning, Johns Manville, or Manson, equal in thickness to the adjoining pipe covering. Where pre-molded fitting insulators are not available, for welded pipe fittings insulate with field fabricated mitered segments of straight pipe insulation without ASJ equal in density and thickness to the adjoining pipe covering. Where pre-molded fitting insulators are not available for screwed or soldered/brazed pipe fittings insulate with field fabricated insulation which shall consist of loose low density glass fiber insulation wrapped and compressed tightly, equal in thickness and density to adjoining straight pipe insulation. Vapor seal with one 1/8" thick wet coat of Foster 30-33, Childers CP-33, or approved equivalent vapor barrier coating, placed over 10 x 10 strands per square inch glass fabric mesh which shall have an emulsion imbedded in it when applied. Apply a second of coating of 1/8" thick Foster No. 30-33, Childers CP-33, or approved equivalent adhesive applied over the mesh and first coating of vapor barrier. This coating application shall result in a minimum total dry film thickness of 37 mils. Vapor barriers - coatings shall have a maximum permeance rating of 0.07 at 43 mils dry film thickness per ASTM E-96, procedure B. Apply a PVC jacketing as specified elsewhere herein over all insulated valves and fittings.
3. Valves, flow control valves, strainers and control valves may be insulated with contoured, custom cut, and fully glued one inch (1") thick closed cell foam type insulation similar to Armaflex or Aerocell sheet or pipe insulation.
4. Finish entire exposed straight pipe insulation installations with PVC sheet jacketing where exposed from the finished floor up to 12'-0" above the finished floor including all portions of horizontal piping that occurs at and extends above 12'-0". Jacketing shall be applied to all straight piping sections, as well as to all elbows, tees, valves, flanges, fittings and other piping accessories. Use "smoke-safe" PVC fitting covers, similar to Speedline 1, Knauf “Proto” or Johns Manville “Zeston 2000.” Suitably seal all jacketing seams with tape, or other approved means, along the entire length and butt joints of jacketing seams. Unless specifically noted otherwise, all PVC jacketing will be white in color.
5. Loose "Diaper" inserts at fittings shall not be allowed.
6. Insulation thickness shall be as follows (per International Energy Conservation Code, 2015):

PIPING SYSTEMS	INSULATION THICKNESS - INCHES P I P E S I Z E S					
	* RUNOUTS 3/4" & SMALLER	LESS THAN 1"	1" TO 1-1/2"	2" TO 3"	4" TO < 8"	8" and OVER
Heating Water (200 Deg. F. or less)	1.50	1.50	1.50	2.00	2.00	2.00
Chilled Water (40-60 Deg. F.)	1.50	1.50	1.50	1.50	1.50	1.50

* Runout piping for individual terminal or fan coil units not exceeding 4'-0" in length between the isolation valves and coils and not exceeding 3/4" in diameter.

7. Chilled water and heating water lines in Main Mechanical Rooms may be covered with 0.016" aluminum jacketing from the finished floor to a point 8'-0" A.F.F., in lieu of PVC sheet jacketing, above 8'-0" PVC sheet jacketing required. All jacketing shall cover straight piping runs, elbows, valves and all other fittings.

B. Water Filled Chilled Water Supply and Return lines any other Water Filled HVAC Lines (such as chemical treatment or water filtration systems) exposed to the Outdoors:

1. Protect to -10 degrees F. by wrapping with heat trace wire with thermostats strapped to lines.

2. Then insulate with 2" thick, 4 lb. or heavier density molded glass fiber jacket covering with FRJ jacket. Insulate fittings same as described earlier herein for chilled and heating water piping.
3. Finally cover with a 0.016" thick aluminum with locked seams and banded joints made watertight. Jacketing shall be equivalent to ITW Insulation Systems aluminum roll jacketing conforming to ASTM B-209, with smooth mill finish.
4. Cover valves, mechanical couplings, and fittings with prefabricated aluminum jacketed fitting covers with factory applied moisture barriers to thickness to match that on piping and band in place. Fitting covers shall be equivalent to Childers ELL-JACS, Tee-Jacs, Flange-JACS, and Valve-JACS. Seal ends to prevent moisture penetration and to make completely weatherproof.
5. Refer to Division 22 for water filled plumbing piping systems located outdoors.

C. Self-Regulating Heat Trace: Refer to Section 23 05 33, Heat Tracing for HVAC piping.

D. Interior Domestic Cold Water Lines: Refer to Division 22.

E. Domestic Hot Water and Hot Water Return Lines: Refer to Division 22.

F. Waste, Drain and Miscellaneous Lines:

1. The drain from each piece of Air Handling Equipment condensate drain pan and all refrigerant suction piping shall be insulated with foamed plastic, Armacell Armaflex or Aeroflex Aerocell slipped on while the piping is being fabricated, and with all joints, butt type, sealed using an adhesive recommended by the manufacturer of the plastic. The insulation shall be continuous from the drain opening in the Air Handling equipment condensate pan to the point of discharge with an open sight air gap over a drain. All formed plastic insulation shall meet ASTM E-84 requirements. Provide 1/2" thick insulation on condensate drains and 1-1/2" thick insulation on refrigerant suction piping. For all “Armaflex” type insulation installed outdoors apply two (2) coats of NOMACO K-Flex R-374, or Foster 30-64, or approved equal, protective coating (ultra-violet rays), white in color.
2. The body of each floor drain and all primary and overflow roof drain bodies, where the body of the drain is out of the ground, or above a ceiling: Refer to Division 22.
3. Waste lines serving electric water coolers and floor drains (includes P-traps) receiving cold condensate from air handling equipment condensate pans to the point where they join the nearest vertical waste stack or sanitary main, all horizontal and vertical primary storm drainage piping to the point of penetration to the underfloor and the first vertical piece of the overflow drain pipe (below the drain body) and the first horizontal section of overflow drain piping to the first three feet (3') of vertical pipe beyond that section: Refer to Division 22.

G. Air Separators, Expansion Tanks, Chemical Shot Feeders and Chilled and Heating Water Storage or Buffer Tanks: Insulate with 2" thick, approximately 4 lb. density fiberglass, pipe or board insulation, rigid, or rigid-scored- for-curvature; carefully cut and/or mitered to fit contours and point up voids and dents with insulating cement. Protect ASME labels from physical damage and being covered with mastic and insulation. Completely expose ASME labels and bevel insulation around such labels and seal exposed cut insulation with mastic. For chilled water system labels provide an "Armaflex" Patch, removable, 1/2" thick. Finish with PVC sheet jacketing similar to piping systems.

H. Chilled Water Pumps: Two inch (2") thick foamed plastic cut to contour of equipment, secured, and vapor barrier applied. Insulation boxes on pumps shall allow accessibility to pumps, i.e. be two-piece and be removable without causing damage to the insulation. Fill voids with packed fibrous insulation to eliminate air pockets therein.

I. Plenum Safe Jacketing:

1. Where non-plenum rated piping (such as PVC, CPVC, FRP, PE, PP, ABS, PVDF, etc.) is installed in return air plenums cover all exposed portions of this piping with a plenum safe jacketing, or wrap, system that is a factory manufactured and tested non-combustible barrier, to flame and smoke spread, designed to encapsulate non-rated or combustible items located in return air plenums, in accordance with the most recent additions of the International Building and Mechanical Codes.
2. Plenum safe jacketing shall be covered with a light weight fiberglass reinforced foil scrim finished high temperature rated insulation with an approximate density of 6 pounds per cubic foot. Jacketing shall have a Flame Spread and Smoke Developed rating of 0 for the unfaced blanket and be under 25 and 50 respectively for these items as tested in accordance with U.L. 723 and ASTM E-84. Maximum Flame Spread in accordance with U.L.1887 shall be 0 feet. Maximum smoke/optical

density and Average Smoke per U.L.1887 testing shall not exceed 01 and 0 respectively. U.L. 1887 test procedure is a modified tunnel test which provides test data for flame spread and smoke density using a single plastic pipe and a bundle of plastic pipes of various sizes subjected to a fire test.

3. Thermal resistance of the barrier system shall be 4.2 as tested in accordance with ASTM C518. The Barrier System shall be able to withstand an operating temperature up to 2,300 Deg. F. and have a melting point of no lower than 3,100 Deg. F.
4. Plenum safe jacketing shall be a minimum 1/2 inch thick and have at least one side covered with a foil skin which must face the outer, or exposed, side. All joints in each direction shall be overlapped a minimum of one inch (1"). Jacket shall be secured tightly around the piping with either stainless steel banding or stainless steel tie wire. Use stainless steel crimp clamps on banding fasteners. Tie wires shall be secured using twist tensioning. Seal all cut edges with aluminum foil tape to ensure there is no exposed fiber.
5. Plenum safe jacketing shall be as manufactured by:

    a. Great Lakes Textiles, Inc. or approved equals by;
    b. 3M Corporation.
    c. Thermal Ceramics.
    d. FyreWrap by Unifrax.

2.2 DUCTWORK INSULATION MATERIALS

A. Duct Insulation - External:

1. Concealed (above ceilings) external duct insulation shall be glass fiber blanket-type insulation of not less than 1 lb. per cu. ft. density with a factory applied flame-retardant vapor barrier facing. Facing shall consist of a layer of aluminum foil, reinforced layer of glass fibers, and a layer of kraft paper all bonded together with fire-retardant and adhesive. Insulation, adhesives, and tapes shall be rated in accordance with U.L. 181A or 181B. Minimum duct wrap insulation thickness shall be two inches (2") thick and be equal to Certainteed Type IV duct wrap.
2. All insulation systems shall meet the requirements of the most recent version of the International Energy Conservation Code, which requires a minimum installed R-value of 6.0 for conditioned, cooled or heated, and outside air system ductwork and plenums when located inside buildings or spaces. Increase insulation thicknesses as required to comply.
3. Water Vapor Permeance shall be no greater than 0.05 Perms per ASTM-E-96.
4. Fire Hazard Classification of installed duct insulation systems shall meet the requirements of ASTM-E-84; Flame Spread of 25, or less; Smoke Developed and Fuel Contributed of 50, or less. All insulation systems, adhesives, mastics, sealants, and tapes shall be U.L. rated for the application. All tapes used shall be acrylic based.
5. All external duct insulation shall be a regularly manufactured product of one of the following:

    a. Knauf.
    b. Owens Corning.
    c. Johns Manville.
    d. Certainteed.
    e. Manson.

B. Duct Insulation - Internal:

1. Internal duct insulation, liner, shall be in thicknesses as indicated herein, and be as specified in Specification Section 23 30 00. Duct liner shall be one inch (1") thick on all return, transfer, and relief air ducts, and on portions of general exhaust air ductwork systems as specified elsewhere herein. Internal duct insulation on all conditioned, cooled or heated, supply, all outside air ductwork systems and all mixed air plenums shall be 1-1/2" thick duct liner. All internal liner in sound sensitive areas (i.e. spaces designed to NC-25 or less) shall receive 2” internal liner for supply and return air ductwork. Sound Sensitive spaces include, but are not limited to, Auditorium, Audience Chamber, Stage, Orchestra Pit, Control Rooms Sound and Light Locks, Studio Theater, Rehearsal Room, and Lounge.
2. All duct liner shall be made of glass fiber coated with a bonded mat on the air stream side of the insulation. Coating shall be neoprene based meeting the requirements of NFPA-90A and U.L. Standard 723. Insulation shall not be less than 1.5 lbs. per cu. ft. density, and have a K-value of 0.28 per ASTM-C-177 at a mean temperature of 75 Deg. F.

3. All insulation systems shall meet the requirements of the most recent version of the International Energy Conservation Code, which requires a minimum installed R-value of 6.0 for conditioned, cooled or heated, supply and all outside air system ductwork and mixed air plenums when located inside buildings or spaces. Increase insulation thickness as required to comply.
4. Fire Hazard Classification of installed duct insulation systems shall meet the requirements of ASTM-E-84; Flame Spread of 25, or less; Smoke Developed and Fuel Contributed of 50, or less.
5. All insulation systems, adhesives, mastics, sealants, and tapes shall be U.L. rated for the application.
6. All duct liner shall be suitable for the air velocities to be encountered in each system, and shall generally be suitable for velocities of up to 6000 FPM.
7. Acceptable duct lining manufacturers shall be:

    a. Certainteed.
    b. Knauf.
    c. Owens Corning.
    d. Johns Manville.
    e. Manson.

C. Flexible Fire Rated Duct Wrap/Boards for Grease Ductwork, Boiler Flues, Dishwash Exhaust Duct, top of hoods exposed above ceilings, and elsewhere noted on Drawings:

1. Where specified elsewhere herein or where indicated on the Drawings, provide a flexible or board type fire rated duct enclosure system on metal ductwork and portions of hoods exposed above a ceiling, where required by the local Code authority, that allows for zero clearance to combustibles and which can be applied directly to the ductwork, and hood, to minimize space needed for the enclosing materials. The wrap or board materials shall be manufactured in various thicknesses, or be able to be installed in multiple layers of a uniform thickness, to obtain an overall fire rating from one to four hours, and to meet the requirements of the local authority having jurisdiction based on the local codes used.
2. The duct wrap, or board, shall be a noncombustible fire-proofing material capable of withstanding temperatures in excess of 2000 Deg. F. and up to 1,800 Deg. F. on a continuous basis. The fire rating of this material shall be uniform over the entire surface, as installed, and shall be suitable for installation on ducts.
3. Refer to Specification Section 23 30 00 for grease and/or fume exhaust and ventilation air duct requirements. Coordinate the fire rated enclosure with that Section of Specifications (typically, minimum 1-hour rated enclosure).
4. Board materials shall be composed of a hydrous calcium silicate made primarily from high purity lime, silica and reinforcing fibers. Joints shall be sealed with a compatible high temperature caulking. Board density shall be a nominal 18 pounds per cubic foot or greater. The R-value shall be approximately 1.7 per inch thickness of the board material. All board materials shall be as manufactured by “PABCO” or approved equals only.
5. Flexible duct wrap materials shall consist of a foil fiberglass reinforced scrim covering over a high temperature rated insulation system designed and rated to provide a fire rated barrier system around duct systems. Flexible duct enclosure systems shall meet all pertinent requirements of the most recent versions of ASTM E2336 and NFPA 96 (Section 4.3.1). This requires a one and one half inch (1-1/2") thick system with two layers of flexible fire wrap. Should the local Code in effect, and the authority having jurisdiction, allow a single layer system complying with the requirements of UL 1978, then this will be permitted. Verify all local code requirements prior to bidding this work. Duct wrap materials shall be as manufactured by:

    a. 3M Corporation or equals by;
    b. Thermal Ceramics (Firemaster), or
    c. FyreWrap by “Unifrax”.

D. One (1) Hour Fire Rated Shaft Alternative for Lab Exhaust Duct Systems: Flexible Wrap Systems used on dryer exhaust systems shall be listed and labeled by an NRTL, Nationally Recognized Testing Laboratory. Labeling on scrim shall include product name and certification mark. Wrap system shall be fully encapsulated to resist moisture absorption. Wrap system shall be tested per ISO 6944, Type A duct, and achieve a one (1) hour rating for Stability, Integrity, and Insulation. Wrap shall also be tested per ASTM E 119, ASTM E 814/UL 1479, and ASTM E-84 or UL/ULC 723. A listed and labeled firestop system shall be available to seal the opening where the protected duct penetrates a fire rated floor or wall. The

wrap system shall be installed with steel tie wire and/or banding per manufacturer's instructions. System is subject to approval of the local Authority Having Jurisdiction (AHJ) with the wrap material being Unifrax FyreWrap® DPS or approved equivalent.

PART 3 - EXECUTION

3.1 GENERAL

A. Apply insulation and pipe covering after all of the piping system to be insulated has been pressure tested, found to be completely tight (without leaks), and accepted as such. All insulated T-handles, blow-down valves, extended handles and caps should be installed prior to commencing with insulation. Verify that control, isolation, and balancing valves and any other piping specialty where a valve stem or test port extends beyond the normal pipe insulation thickness to be installed is installed pointed upward vertically. Thoroughly clean and dry all surfaces prior to being covered. Chilled water systems, chillers and respective distribution pumps, shall be turned off, chilled water in piping shall have equalized with the average ambient temperature and all condensation shall be completely dried off of the pipe.

B. For operational systems, perform work after operational hours and only during periods of scheduled equipment shutdown. During this period chilled water flow to the piping segments to be insulated shall be stopped and the water and piping shall have equalized in temperature with the average ambient temperature of the space in which the piping is installed. If time does not permit this to occur then apply heat to the piping in a controlled, suitable manner, to warm the water and pipe sufficient to prevent any condensation from occurring during the insulation process. For any segments to be left uninsulated until the next system shutdown, mastic seal the ends and penetrations through of the installed insulation and allow sealant to dry prior to re-energizing the chilled water system. Continue to insulate the piping system in small enough portions after-hours, or as required, to insure no insulation is applied over a wet surface.

C. In the covering of surfaces subject to low temperatures (below 60 Deg. F.), take extreme precautions to secure a complete vapor seal and avoid air pockets of any kind within the insulation. All insulation shall be tightly fitted to the piping system and all systems shall have an equal thickness and density of insulation around all piping, valves, strainers, accessories, etc. Where fiberglass insulation is cut to contour insulation around valves or strainers add additional insulation to obtain the overall insulation thickness specified. Where vapor barrier jackets are lapped at seams and joints, paste such flaps carefully to assure no break in the vapor seal. Seal around butt joints with strips of vapor barrier jacket. Coat all taped ASJ butt and longitudinal seams with vapor barrier coating to prevent moisture ingress. Use self-sealing laps on all insulation for pipes carrying a medium below 60 Deg. F. Stapling will not be permitted where vapor barrier jackets are specified. Vapor barriers for these systems shall have a perm rating not to exceed 0.05.

D. On glass fiber pipe covering with factory applied vapor barrier jacket, lap the jacket on the longitudinal seams and seal with vapor barrier lap adhesive equivalent to Foster 85-20 or Childers CP-82. Tightly butt the ends and cover butt joints with a 4" wide band of vapor barrier jacket secured with the same adhesive. On piping systems with contents below ambient temperature, coat all taped ASJ butt and longitudinal seams with vapor barrier coating to prevent moisture ingress. At all run-out piping to chilled water equipment mastic seal, with specified vapor barrier coating to prevent moisture ingress from one section of piping to another, the ends of the branch piping insulation, where it meets the main piping insulation, to prevent the migration of moisture should it ever become trapped in the insulation system. Generally, mastic seal the ends of butt joints in chilled water piping systems every 50 feet for the entire system with the specified vapor barrier coating.

E. Where jacketing systems are specified, use standard weight, PVC sheet rolls. Exercise care to locate seams in an inconspicuous place and apply all jacketing neatly, including that on valves and fittings. Unsightly work will be considered a justifiable basis for rejection. Adhere the jacketing in all cases with a lagging adhesive, Foster 30-36 AF (Anti-Fungal) or Childers CP-137 AF, or by other approved methods.

Adhesives shall have mold and mildew inhibitors. Lagging adhesives shall meet ASTM D 5590 with a “0" growth rating.

F. All insulation shall be continuous through wall and ceiling openings and sleeves. Use exterior duct wrap insulation on the outside of smoke and fire damper sleeves. Create a secondary sleeve around the primary sleeve to allow a complete insulation system as allowed by the local authority having jurisdiction.

G. All insulation and accessories shall have composite (insulation, jacket and adhesive used to adhere the jacket to the insulation) fire and smoke hazard ratings as tested under procedure ASTM E-84, NFPA 255, and UL 723 not exceeding:

Flame Spread	25
Smoke Developed	50
Fuel Contributed	50

H. No insulation shall be applied to the bodies of unions and flanges on building heating water supply and return lines only. Terminate the insulation short of the unions or flanges at this equipment, and bevel off at a forty five degree angle to permit "breaking" the union or removal of the flange bolts without damaging the insulation. Bevel the insulation off also at caps on scale pockets, and blow-off connections on strainers, and at valve bonnets on these same systems. All valves, unions, flanges, strainer blow-off and drain caps for chilled water systems shall be fully insulated.

I. Unsightly work shall be cause for rejection, including poor application of adhesives and coatings beyond the insulation which coats valves or other piping specialties.

J. Damage or Modification to Insulation: Where new insulation is disturbed or damaged during the process of installing other new materials, making new connections, etc., it shall be repaired or replaced to return it to its original condition and appearance. Where lines are removed and connections to insulated lines are capped, insulate those caps as well as repairing damaged insulation. Materials shall match those presently installed in thickness, density, insulating value, jacketing, etc.

K. Miscellaneous Lines: Piping connected to chilled or hot water lines through which there might be fluid flow on occasions such as the lines connected to air vents, lines running to compression tanks, etc. shall be insulated as described for other piping in those systems.

L. Hanger and Support Locations: At the location of hangers or supports for pipes run above ground and finished with a vapor seal insulation, provide rigid sections of cork, Foamglas, calcium silicate or high density polyurethane, at least the same thickness as the adjacent insulating material to adequately support the pipe without compression of the insulating material and cover with a vapor seal that is bonded to the adjacent insulation as described for fittings in the lines. Where the insert has an insulating value less than the adjacent pipe insulation the thickness of the insert shall be increased to equal the insulating value of the adjacent pipe insulation. Wood inserts shall not be allowed. Hangers and supports for piping insulation to receive a vapor barrier shall be installed exterior to the insulation.

M. Material Changes: Wherever there is a change in materials on lines that are vapor sealed, apply a suitable vapor barrier that is compatible with both materials, tapes, etc., as required to maintain the vapor barrier.

N. The following describes materials, thickness and finishes for insulation on piping. In the following "exposed" shall mean any line or duct exposed below the finished ceiling and structure where no ceiling is installed, in any room space, area, mechanical rooms, closets, and any line or duct run exterior to the building, including above the roof. "Concealed" shall mean any line or duct located above ceilings, in furrings, in chases, in crawl spaces, and buried in direct contact with the soil.

O. In all "exposed" areas, up to 12'-0" above the finished floor, insulation shall receive a PVC jacketing system. Neatly install all insulation systems not receiving jacketing such that they are suitable for finish painting.

P. All insulation materials and jacketing shall exhibit the following characteristics:

1. Water absorption, per ASTM C 1104, shall be less than 0.02%.
2. Linear shrinkage, per ASTM C 356, shall be negligible.
3. Stress corrosion, per ASTM C 795, shall not cause corrosion.
4. Corrosiveness, per ASTM C 665, shall not be any greater than sterile cotton.
5. Resistance to fungi, mold and mildew and bacteria, per ASTM C 665, shall be rated as not promoting growth of fungi and bacteria. Inhibitors shall be added to specified products to meet these requirements.

3.2 DUCTWORK

A. Duct Insulation - Internal: Provide sound absorbing and thermal insulation to the interior surface of the following duct systems: All rectangular medium pressure supply, low pressure supply, return, relief, transfer, and outside air ducts and supply, mixed, and return air plenums for the first 10'-0" from the units. All exposed ductwork in crawlspace, occupied space, or mechanical rooms shall be internally lined. Additionally, line the first 10 feet of general exhaust ducts, except fume, and other industrial exhaust systems, on both sides of in-line fans and for the first 10'-0" from the fan curb toward the occupied space for roof mounted fans. All return air and relief air ductwork in shafts or furr outs near sound sensitive areas (as noted on drawings) shall be lined down to floor penetration. All supply air ductwork mains downstream of terminal units serving sound sensitive spaces such as conference rooms, Video or other spaces designated on the drawings shall be lined for length of duct. All ductwork in the board room space shall be internally lined. All lined ductwork shall be increased in size to maintain the clear inside (air stream) dimensions designated on the Drawings.

1. Duct liner shall be applied in accordance with the manufacturer's recommendations, with the coated, or mat-faced, surface located away from the metal (exposed to air stream). It shall be adhered to the metal with Foster 85-60 or Childers CP-127 adhesive applied to the entire inner surface of the duct. The liner shall be further secured to the duct with Graham Insulating Pins and Clips or other metal clips of the type which do not protrude through the duct. Those clips shall be installed on not greater than 12" centers both ways. All seams and openings in the liner shall be carefully sealed with adhesive.
2. Paint all joints in liner and butter the edges of sections where sections of ductwork will be joined using Foster No. 30-36 or Childers CP-137, or equivalent approved adhesive. Alternately, use a black "duct butter" which shall be Childers CP-135-2.
3. Where damper rods occur, suitable metal bushings shall be provided on each end of the damper rod inside the duct, to provide clearance between the damper blade and the lining.
4. Refer to Section 23 30 00 as applicable, Air Distribution Duct Systems.
5. Due to the most recent version of the International Energy Conservation Code, conditioned air, heated or cooled air (includes outside air intake ductwork), ductwork insulation located inside the building envelope shall have a minimum installed R-value of 6.0. For lined ductwork, this shall be accomplished by using 1-1/2" thick duct liner. Coordinate insulation requirements with other Sections of these Specifications.

B. Duct Insulation - External:

1. Externally insulate all rectangular and round supply and return air ducts not containing internal lining.
2. Additionally insulate the outside of all fire, fire-smoke, and smoke damper sleeves penetrating walls and floors to insure a continuous insulation system.
3. External insulation shall be applied in accordance with the manufacturer's recommendations by impaling over pins using speed clips or be secured with adhesive.
4. Seal all joints, breaks, fastener penetrations and punctures with a 3" wide vapor barrier strip similar to that of facing materials secured with adhesive. Pins shall be spaced 12" on center both ways. Adhesive shall cover the entire duct surface.
5. Blanket type insulation shall generally be used on concealed ductwork only with rigid insulation board being used exclusively on exposed ductwork, which shall also receive a PVC jacket when located 12'-0", or less, above the finished floor.
6. Vapor Seal all jacketing penetrations, cut openings, and cut edges and taped seams with an approved vapor barrier coating, Foster 30/33 or Childers CP-33 vapor barrier coating. All vapor

barrier coatings shall have a maximum permeance rating of 0.07 or less at 45 mils dry per ASTM-E-96, procedure B.

3.3 SHIELDS AND INSERTS

A. Metal saddles, shields, shall be applied between hangers or supports and the pipe insulation. Saddles shall be formed to fit the insulation and shall extend up to the centerline of the pipe and the length specified for hanger inserts. Shields shall be made of galvanized sheet metal and shall be of sufficient size and length to prohibit the crushing of the insulation materials. Saddle shields shall be as follows:

Pipe Size	Metal Saddles	
	Metal Gauge	Length
3/4" to 3"	18	12"
4" to 6"	16	12" - 18"
8" to 10"	14	24"
12" & Larger	12	24"

B. Provide inserts of calcium silicate on hot piping and cellular glass or 7#/Cu. Ft. fiber glass pipe insulation on cold piping at hangers except pipes 1-1/2" or smaller in size. Inserts between the pipe and pipe hangers shall consist of rigid pipe insulation of a thickness equal to the adjoining insulation and shall be provided with vapor barrier where required. Insulation inserts shall not be less than the following lengths:

Pipe Size	Insert Length
3/4" to 3"	12"
4" to 6"	12" - 18"
8" to 10"	24"
12" & Larger	24"

END OF SECTION

SECTION 23 08 00

MECHANICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other divisions for coordination of work with other portions of Work.

1.2 DESCRIPTION

A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that Systems and Operations and Maintenance (O&M) documentation is complete.
4. Verify that the Owner's operating personnel are adequately trained in the O&M of these systems.

B. The systems to be commissioned include: air handlers, fan coil units, boilers, air-cooled chillers, electric unit heaters, pumps, split DX A/C units, fans, fan powered and single duct VAV terminals, Roof-top AC units, UV Light arrays, airflow monitoring stations, and all related controls.

C. Commissioning requires the participation of Division 23 and 26 system installers to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 23 installers shall be familiar with all parts of the commissioning plan issued by the Commissioning Authority (C.A.) and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

D. Commissioning Team members shall consist of the Commissioning Authority (C.A.), the designated representative of the Owner, the General Contractor (GC, CM or Contractor), the architect and design engineers (particularly the mechanical engineer), the Mechanical Contractor (MC), the Electrical Contractor (EC), the Testing, Adjusting, and Balancing (TAB) representative, the Controls Contractor (CC), and any other installing subcontractors or suppliers of equipment pertinent to the complete installation of Division 23 and 26 Systems intended to be Commissioned. The Owner's representative for operations and maintenance shall also be a member of the commissioning team.

1.3 COMMISSIONING AUTHORITY

A. The commissioning agent shall be a licensed professional engineer in the State where the work will be performed, and shall be experienced in the commissioning of mechanical and electrical systems of the type installed in this project. Experience in the construction process, direct digital control systems, Testing, Adjusting, and Balancing; and ASHRAE Guideline 1.1-2007 is mandatory. The commissioning agent shall not be associated with or employed by a mechanical contractor, or equipment supplier. Commissioning Services shall be directly contracted by the General Contractor. Commissioning agency shall be one of the following:

1. Delta T.
2. Engineered Air Balance.

B. COMMISSIONING PLAN

C. Commissioning Plan provides guidance in the execution of the commissioning process. Just after the initial commissioning scoping meeting the CA will provide the plan, which will continue to evolve and expand as the project progresses. The project *Specifications* shall take precedence over the *Commissioning Plan*.

D. Commissioning Process includes a narrative that provides a brief overview of the typical commissioning tasks during construction and the general order in which they will occur.

1. Commissioning during construction begins with a scoping meeting conducted by the CA where the commissioning process is reviewed with the commissioning team members.
2. Additional meetings will be required throughout the active construction phase, as scheduled by the CA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
3. Equipment documentation is submitted to the CA during normal submittals, including detailed start-up procedures.
4. The CA works with the pertinent subcontractors in developing startup plans and startup documentation formats, including prefunctional checklists to be completed, during the startup process.
5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.
6. The Subcontractors, under their own direction, execute and document the prefunctional checklists and perform startup and initial checkout. The CA documents that the checklists and startup were completed according to the approved plans. This may include the CA witnessing start-up of selected equipment.
7. The Subcontractors develop proposed specific equipment and system functional performance test (FPT) procedures. The CA will review these procedures and develop the official FPT procedures to be incorporated into the project.
8. The procedures are executed by the Subcontractors, under the direction of, and documented by the CA.
9. Items of non-compliance in material, installation or setup are corrected at the Subcontractor’s expense and the system is then retested.
10. The CA reviews the O&M documentation for completeness.
11. Commissioning is intended to be completed before Substantial Completion.
12. The CA reviews, pre-approves and coordinates the training provided by the Subs and verifies that it was completed.
13. Deferred testing is conducted, as specified or as required.

1.4 RESPONSIBILITIES

A. General Contractor (GC):

1. Facilitate the coordination of the commissioning work as outlined by the CA, and with the assistance of the CA, ensure that all commissioning activities are being scheduled into the master construction schedule.
2. Include all costs of commissioning, as outlined herein and elsewhere, in the total contract price.
3. Furnish one (1) copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to equipment to be commissioned to the CA.
4. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and complete training.
5. Ensure that all subcontractors execute their commissioning responsibilities according to the Contract Documents and schedule.
6. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the CA to facilitate the Commissioning process.
7. Coordinate the training to be provided to the Owner’s personnel.
8. Prepare O&M manuals and systems manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to “as-built” conditions.
9. Warranty Period:

a. Ensure that Subcontractors execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
b. Ensure that Subcontractors correct deficiencies and make necessary adjustments to O&M manuals and “as-built” drawings for applicable issues identified in any seasonal testing.

B. Mechanical and Controls Systems Installers:

1. Commissioning responsibilities applicable to each of the mechanical and controls (systems installers) of Division 23 are as follows (all references apply to commissioned equipment only):

a. Construction and Acceptance Phases:

1) Include the cost of commissioning in the contract price.
2) In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, Systems and O&M data and training.
3) Attend a commissioning scoping meeting and other meetings necessary to facilitate the Commissioning process.
4) Contractors shall provide the CA with normal cut sheets and shop drawing submittals of all equipment to be commissioned.
5) Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.
a) Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.
b) The Commissioning Agent may request further documentation necessary for the commissioning process.
6) Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.
7) Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
8) Preparing proposed specific functional performance test procedures for submission to and consideration of the CA. The CA will use these submittals to prepare finalized test procedures. Subcontractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests, as applicable.
9) Develop a full start-up and initial checkout plan using manufacturer’s start-up procedures and the prefunctional checklists from the CA for all commissioned equipment. Submit to CA for review and approval prior to startup.
10) During the startup and initial checkout process, execute the mechanical-related portions of the prefunctional checklists for all commissioned equipment.
11) Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
12) Address current A/E punch list items before functional testing. Air TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air related systems.
13) Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

14) Perform functional performance testing under the direction of the CA for specified equipment. Assist the CA in interpreting the monitoring data, as necessary.
15) Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, and A/E and retest the equipment.
16) Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to “as-built” conditions.
17) Prepare redline “as-built” drawings for all drawings and final “as-builts” for contractor-generated coordination drawings.
18) Provide training of the Owner’s operating personnel as specified.
19) Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

b. Warranty Period:

1) Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
2) Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

C. Mechanical (Systems Installer) Contractor:

1. The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:

a. Provide startup for all HVAC equipment, except for the building automation control system.
b. Assist and cooperate with the TAB contractor and CA by:

1) Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
2) Including cost of sheaves and belts that may be required by TAB.
3) Providing temperature and pressure taps in piping and equipment according to the Construction Documents for TAB and commissioning testing. Verify locations for taps with the CA before installation.

c. Prepare a schedule for Division 23 equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.
d. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.

D. Controls (Systems Installer) Contractor (CC):

1. The commissioning responsibilities of the controls contractor, during construction and acceptance phases in addition to those listed in (A) are:

a. Sequences of Operation Submittals. The Controls Contractor’s submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:

1) An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
2) All interactions and interlocks with other systems.
3) Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
4) Written sequences of control for packaged controlled equipment. (Equipment manufacturers’ stock sequences may be included, but will generally require additional narrative).
5) Start-up sequences.

6) Warm-up mode sequences.
7) Normal operating mode sequences.
8) Unoccupied mode sequences.
9) Shutdown sequences.
10) Capacity control sequences and equipment staging.
11) Temperature and pressure control: setbacks, setups, resets, etc.
12) Detailed sequences for all control strategies, e.g., optimum start/stop, staging, optimization, demand limiting, etc.
13) Effects of power or equipment failure with all standby component functions.
14) Sequences for all alarms and emergency shut downs.
15) Seasonal operational differences and recommendations.
16) Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
17) All sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

b. Control Drawings Submittals shall include:

1) Control drawings shall have a key to all abbreviations.
2) Control drawings shall contain graphic schematic depictions of each system and each component.
3) Schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4) Provide a full points list with at least the following included for each point:
    a) Controlled system.
    b) Point abbreviation.
    c) Point description.
    d) Display unit.
    e) Control point or setpoint (Yes / No).
    f) Monitoring point (Yes / No).
    g) Intermediate point (Yes / No).
    h) Calculated point (Yes / No).
    i) Key:
        1) Point Description: DB temp, airflow, etc.
        2) Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
        3) Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
        4) Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
        5) Calculated Point: “Virtual” point generated from calculations of other point values.
5) Controls Contractor shall keep the CA informed of all changes to this list during programming and setup.

c. An updated “as-built” version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
d. Assist and cooperate with the TAB contractor in the following manner:

1) Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
2) Have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.
3) Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

e. Assist and cooperate with the CA in the following manner:

1) Execute the functional testing of the controls system as specified for the controls contractor.
2) Assist in the functional testing of all equipment specified.

f. 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 functional performance testing, according to the process. 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 downloading programs to local controllers and verifying that they are addressed correctly.
   c) Process of performing operational checks of each controlled component.
   d) Plan and process for calibrating valve and damper actuators and all sensors.
   e) 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 TAB using the control system for TAB work. Coordinate with the CA and TAB contractor for this determination.

g. Provide a signed and dated certification to the CA and CM or GC upon completion of the checkout of each controlled device, equipment and
system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.

h. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified.

i. List and clearly identify on the “as-built” duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

E. TAB Contractor. The duties of the TAB contractor, in addition to those listed above are:

1. Submit the outline of the TAB plan and approach for each system and component to the CA prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.

2. Submitted plan will include:
    a. Reviewed the construction documents and the systems to sufficiently understand the design intent for each system.
    b. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
    c. Detailed step-by-step procedures for TAB work for each system and issue.
    d. Plan for formal deficiency reports (scope, frequency and distribution) and final report.
3. Submit reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA as required.
4. Communicate to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB, which affect the control system setup and operation.
5. Provide a draft TAB report to the CA. The report should follow the latest reporting recommendations by AABC.
6. Provide the CA with any requested data, gathered, but not shown on the draft reports.
7. Provide final TAB reports in the number required.

F. Equipment Suppliers:

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with Subs.
3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CA.
4. Provide information requested by CA regarding equipment sequence of operation and testing procedures.
5. Review test procedures for equipment installed by factory representatives.

G. Commissioning Agent (CA):

1. The CA is <u>not</u> responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CA may assist with problem-solving non-conformance items or deficiencies, but ultimately that responsibility resides with the general contractor and the A/E. The primary role of the CA is to develop and coordinate the execution of a testing plan, observe and document performance so that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. Contractor and all subcontractors shall provide all tools or the use of tools to start, checkout and functionally test equipment and systems, to include any specified or required testing equipment needed to conduct these tests.
2. Construction Phase:
    a. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
    b. Coordinate the commissioning work and, with the GC, ensure that commissioning activities are being scheduled into the master schedule.
    c. Revise, as necessary, *Commissioning Plan—Construction Phase.*
    d. Plan and conduct a commissioning scoping meeting.
    e. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
    f. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
    g. Review normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, along with A/E reviews.
    h. Assist in the development of prefunctional tests and checklists.

i. Assist in the development of an enhanced start-up and initial systems checkout plan with Subcontractors.
j. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
k. Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
l. Witness all or part of any ductwork testing and cleaning procedures, if required, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
m. Approve prefunctional tests and checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot-checking.
n. Approve systems startup by reviewing start-up reports and by selected site observation.
o. With necessary assistance and review from installing contractors, review the functional performance test procedures for equipment and systems. This may include energy management control system trending, or manual functional testing.
p. Analyze any functional performance trend logs and monitoring data to verify performance.
q. Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
r. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
s. Oversee and approve the training of the Owner's operating personnel.
t. Compile and maintain a commissioning record and building systems book(s).
u. Review and approve the preparation of the O&M and Systems manuals.
v. Provide a final commissioning report.

3. Warranty Period:

a. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
b. Return to the site at 10 months into the 12-month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

1.5 SCHEDULING

A. The CA will work with the GC according to established protocols to schedule the commissioning activities. The CA will provide sufficient notice to the CM and GC for scheduling commissioning activities.

B. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the applicable Division 23 or 26 contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all

standard testing equipment for the HVAC system and controls system in Division 23, except for equipment specific to and used by the TAB firm in their commissioning responsibilities.

B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents, shall be included in the Base Bid price of the Contractor and be left on site.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in 23 05 93. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of + or - 0.5°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed to the test equipment or certificates of calibration shall be readily available with a copy being furnished to the C.A. for their records.

PART 3 - EXECUTION

3.1 MEETINGS

A. Scoping Meeting. Within 90 days of commencement of construction, the CA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the GC. Information gathered from this meeting will allow the CA to revise the *Commissioning Plan* to its "final" version, which will also be distributed to all parties.

B. Miscellaneous Meetings will be planned and conducted by the CA as required as the construction phase progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subcontractors. The CA will plan these meetings and will minimize unnecessary time being spent by Subcontractors, or any other member of the Commissioning Team.

3.2 REPORTING

A. CA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.

B. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

C. A final summary report by the CA will be provided focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Prefunctional checklists, functional tests and monitoring reports will be part of the final report, and the entire report will be included in the O&M manuals.

3.3 SUBMITTALS

A. CA will provide appropriate contractors with a specific request for the type of submittal documentation the CA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. All documentation requested by the CA will be included by the Subs in their O&M manual contributions.

B. Commissioning Agent will be given the opportunity to review all pertinent submittals related to equipment or systems to be commissioned for conformance to the Contract Documents, and more specifically as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning Agent will notify the appropriate persons as requested, of items missing or areas that are not in conformance with Contract Documents as it relates to the commissioning process, and which require resubmission.

C. CA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.

D. Submittals sent to the CA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, although the CA will review them.

3.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

A. The following procedures apply to all equipment to be commissioned. Some systems that are not comprised so much of actual dynamic machinery may have very simplified PCs and startup.

B. Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

C. Start-up and Initial Checkout Plans will be required by the CA who shall assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the CA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms. Parties responsible for executing functional performance tests are identified in the testing requirements.

1. Checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
2. Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form may have more than one trade responsible for its execution.
3. Each Subcontractor responsible for the purchase of each item of equipment shall develop the full start-up plan for that equipment by combining (or adding to) the CA's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. The full start-up plan could consist of something as simple as:

    a. Prefunctional checklists developed jointly by the CA and the subcontractors.
    b. Manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
    c. Manufacturer's normally used field checkout sheets.

4. Each Subcontractor shall submit the full startup plan for which they are responsible to the CA for review and approval.
5. CA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
6. Full start-up procedures and the approval form may be provided to the CM for review and approval, depending on management protocol.

D. Sensor Calibration of all sensors shall be included as part of the prefunctional checklists performed by the Contractors, according to the following procedures:

1. Sensors Without Transmitters, Standard Application type, shall include taking readings with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.

Sensor	Required Tolerance (+/-)		Sensor	Required Tolerance (+/-)
Unit wet bulb or dew point	1.0 Deg.F.		Flow rates, air	10%of design
Indoor and outdoor air pressure differential	0.05 Inches W.G.		Pressures, air	5% of design
Outside air, space air, coil air temps	1.0 Deg.F.		Watt-hour, voltage & amperage	2%

E. Execution of Prefunctional Checklists and Startup.

1. Four weeks prior to startup, the Subcontractors and pertinent vendors shall schedule startup and checkout with the GC and CA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
2. CA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used as approved).
3. For lower-level components of equipment, (e.g., fans, sensors, controllers), the CA shall observe a sampling of the prefunctional and start-up procedures. The sampling procedures are identified in the commissioning plan.
4. Subcontractors and vendors shall execute startup and provide the CA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
5. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for supervisors to fill out these forms if they have not witnessed the test.

F. Deficiencies, Non-Conformance and Approval in Checklists and Startup:

1. Subcontractors shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CA within two days of test completion.
2. CA reviews the report and submits either a non-compliance report or an approval form to the Sub or GC. The CA shall work with the Subcontractors and vendors to correct and retest deficiencies or uncompleted items. The CA will involve the GC and others as necessary. The installing Subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CA recommends approval of the execution of the checklists and startup of each system using a standard form.

3.5 FUNCTIONAL TESTING

A. This sub-section applies to all commissioning functional testing for all Divisions.

B. Objectives and Scope of functional testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation

(seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, no flow, equipment failure, etc. shall also be tested.

C. Development of Written Test Procedures shall begin with the CA obtaining all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CA shall then, with the assistance the contractor, develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Subcontractor or vendor responsible to execute a test, shall provide assistance to the CA in developing the procedures (answering questions about equipment, operation, sequences, etc.). Prior to execution, Subcontractors shall review the tests for feasibility, safety, equipment and warranty protection. The CA may submit the tests to the A/E for review, if requested. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

D. Test Methods shall include the following:

1. Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CA will determine which method is most appropriate for tests that do not have a method specified.
2. Simulated Conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Altering Set points rather than overwriting sensor values, and when simulating conditions is difficult, altering set points to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout set point to be 2F above the current outside air temperature.
4. Setup of each function and testing shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

E. Coordination and Scheduling by the Subcontractors shall provide sufficient notice to the CA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CA will schedule functional tests through the GC and affected Subcontractors. The CA shall direct, witness and document the functional testing of all equipment and systems. The Subcontractors shall execute all tests. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation by the CA shall include witnessing and documenting the results of all functional tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the GC for review. CA will include the filled out forms in the Commissioning Report.

B. Non-Conformance.

1. CA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported on a standard non-compliance form.

2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form.
3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.
4. As tests progress and a deficiency is identified, the CA discusses the issue with the executing contractor.
    a. When there is no dispute on the deficiency and the Subcontractor accepts responsibility to correct it:
        1) CA documents the deficiency and the subcontractor response and intentions and they go on to another test or sequence
    b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
        1) The deficiency shall be documented on the non-compliance form with the Subcontractor's response and a copy given to the GC and to the Subcontractor representative assumed to be responsible.
        2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Owner.
        3) The CA documents the resolution process.
        4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CA. The CA reschedules the test and the test is repeated until satisfactory performance is achieved.
5. Cost of Retesting for the Subcontractor to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.
6. Contractor shall respond in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
7. CA retains the original non-conformance forms until the end of the project.

C. Approval by the CA shall include notation of each satisfactorily demonstrated function on the test form. CA recommends acceptance of each test using a standard form. The Owner gives final approval on each test using the same form, providing a signed copy to the CA and the Contractor.

3.7 SYSTEMS and OPERATION AND MAINTENANCE (O&M) MANUALS

A. Following System and O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

B. Division 23 shall compile and prepare documentation for all equipment and systems covered in Division 23 and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section, prior to the training of owner personnel.

C. CA shall receive a copy of the Systems/O&M manuals for review.

D. Special Control System O&M Manual Requirements shall include, in addition to documentation that may be specified elsewhere, the controls contractor compiling and organizing, at minimum, the following data on the control system in labeled 3-ring binders with indexed tabs:

1. Three (3) copies of the controls training manuals in a separate manual from the O&M manuals.
2. Operation and Maintenance Manuals containing:
    a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this

system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included if required in the controls specification section.

b. Full as-built set of control drawings.
c. Full as-built sequence of operations for each piece of equipment.
d. Full points list. In addition to the updated points list required in the original submittal.
e. Full print out of all schedules and set points after testing and acceptance of the system.
f. Full as-built print out of software program as required.
g. Electronic copy on disk of the entire program for this facility if required.
h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.
i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
j. Control equipment component submittals, parts lists, etc.
k. Warranty requirements.
l. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

3. Manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:

a. Sequences of operation.
b. Control drawings.
c. Points lists.
d. Controller / module data.
e. Thermostats and timers.
f. Sensors and DP switches.
g. Valves and valve actuators.
h. Dampers and damper actuators.
i. Program setups (software program printouts).

4. Field checkout sheets and trend logs should be provided to the CA for inclusion in the Commissioning Record Book.

E. Review and Approval of the commissioning related sections of the Systems and O&M manuals shall be made by the A/E and the CA.

3.8 TRAINING OF OWNER PERSONNEL

A. GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

B. CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

C. Mechanical Contractor shall have the following training responsibilities:

1. Provide the CA with a training plan two weeks before the planned training.
2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, heat rejection equipment, air conditioning units, air handling units, fans, controls and water treatment systems, etc.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. Controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. Training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:
    a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    b. A review of the written Systems/O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
    c. Discussion of relevant health and safety issues and concerns.
    d. Discussion of warranties and guarantees.
    e. Common troubleshooting problems and solutions.
    f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
    g. Discussion of any peculiarities of equipment installation or operation.
    h. The format and training agenda in *The HVAC Commissioning Process, ASHRAE Guideline* 1.1-2007 is recommended.
    i. Classroom sessions shall include the use of overhead projections, slides, and video/audio-taped material as might be appropriate.
9. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and preventative maintenance for all pieces of equipment.
10. Mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.
11. Duration of Training by the mechanical contractor shall include providing training of sufficient length on each piece of equipment according to the requirements of the preceding specification sections. If not listed in the equipment sections, the following schedule shall be used.

Hours	System
2	Split DX A/C Units
3	Exhaust Fans
8	Air Handlers
4	VAV Terminals
2	Electric Unit Heaters
8	Boilers
8	Air-Cooled Chillers
6	Pumps

D. Controls Contractor shall have the following training responsibilities:

1. Provide the CA with a training plan four weeks before the planned training.
2. Controls contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.
3. Training manuals shall include the standard operating manual for the system and any special training manuals which shall be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals *and* in all software displays. Copies of audiovisuals shall be delivered to the Owner.
4. Training will be tailored to the needs and skill-level of the trainees.

5. Trainers will be knowledgeable on the system and its use in buildings. The Owner shall approve the instructor prior to scheduling the training.
6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
7. Controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
8. There shall be three training sessions:

    a. Training I - Control System: The first training shall consist of 24 hours of actual training. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    b. Training II - Building Systems: The second session shall be held on-site for a period of _16_ hours of actual hands-on training after the completion of system commissioning. The session shall include instruction on:

        1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.
        2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
        3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
        4) Every screen shall be completely discussed, allowing time for questions.
        5) Use of keypad or plug-in laptop computer at the zone level.
        6) Use of remote access to the system via phone lines or networks if included.
        7) Setting up and changing an air terminal unit controller.

    c. Training III - General Overview: The third training will be conducted on-site six months after occupancy and consist of 16 hours of training. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

E. TAB contractor shall have the following training responsibilities:

1. TAB shall meet for 2 hours with facility staff after completion of TAB and instruct them on the following:

    a. Go over the final TAB report, explaining the layout and meanings of each data type.
    b. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
    c. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
    d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
    e. Other salient information that may be useful for facility operations, relative to TAB.

3.9 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the start-up and initial checkout plan described and the filled out start-up, initial checkout, pre-functional, and functional checklists, training plans and records of training. These work products will be supplied to the CA to be included in the final commissioning report.

END OF SECTION

SECTION 23 09 00

CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and all referenced documents.

B. Comply with Sections 23 00 00 and 23 05 00, General Provisions, and all other Division 23 Sections, as applicable.

C. Refer to other Divisions for coordination of work with other trades.

1.2 SYSTEM DESCRIPTION

A. The scope shall include the furnishing and installing of Energy Management System devices with new direct digital controllers, all local and remote control panels, temperature control field devices, appurtenances, etc., to accomplish specific control sequences specified herein, to provide fire and freeze protection; cocks and wells for various temperature and pressure control, sensing and indicating devices; pressure and temperature indicating instruments; supporting structures, and other required components for a complete and operating system.

B. The scope shall include all new electric connections to new thermostats, sensors, valves, dampers, actuators, switches and relays, and all other new components of the system requiring electric connections.

C. The scope shall further include all temperature control and interlocking wiring and wiring devices, including raceways, as indicated herein.

D. Provide all software programs as required to effect the sequences of control, monitoring, reporting, etc., as indicated herein.

E. The new system installed shall be fully automatic, subject to various types of remote surveillance, routine remote adjustments, remote status, remote alarms, remote data collection for trending/historical files, and other operations as indicated herein, from a new local remote microprocessor-based Local Area Network (LAN), with the local system capable of stand-alone operation. The system shall be capable of being monitored and controlled remotely on site by an IBM compatible Workstation and off site by a Central Work Station located at the Higher Education Center via web access.

F. Bidders are specifically advised that full and effective two-way communication between the new system installed under this contract and the Owner's existing Central EMS must be achieved in an approved manner, including whatever may be required in the form of interface hardware and software without effecting or interrupting other system software. Simultaneous on-line communication of this system and others with the Central EMS is mandatory.

G. This system of equipment and software shall be provided and installed by the single local factory trained and authorized sales, installation and service agent of Reliable (Enviromatic Systems) or Schneider Controls.

1.3 QUALITY ASSURANCE

A. The equipment provided under this Section of the Specifications shall be installed, calibrated, adjusted, and put in completely satisfactory operation by a Control Systems installer experienced in this type of work.

B. The successful Control Systems installer shall meet the following requirements:

1. All spare parts must be locally stocked and readily available within a 24 hour period.
2. Service personnel shall be available, on call, on a 24 hour a day, year round basis, or service personnel will respond by visitation to the site within four (4) hours of a service call considered serious in nature or classified by the Owner as an emergency.
3. Be able to provide evidence of having successfully installed similar sized and types of systems for a minimum of ten (10) years.
4. Bids by wholesalers, distributors, mechanical contractors and non-franchised contractors shall not be acceptable.
5. All work described in the Plans and Specifications shall be installed, wired, and commissioned by factory certified technicians qualified for this work and in the regular employment of the control system manufacturer's local office.
6. A local office is defined as a corporate branch office or an independently owned office with a current contractual agreement with the system manufacturer that allows the office to purchase, install, and service the manufacturer's products.
7. The local office shall be full service facility within 50 miles of the project site. The local office shall be staffed with engineers and technicians trained on the installation, commissioning, and service of energy management and control systems.

C. All control devices shall be as specified in the technical portion of this section of the specifications. The system shall be installed by workmen skilled, experienced, and specifically trained in the application, installation, calibration, adjusting, and testing of instrumentation of the type specified.

D. All control system components shall operate satisfactory without damage at 110% above and 85% below rated voltage and at + 3 hertz variation in line frequency. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. All bus connected devices shall be A.C. coupled, or equivalent, so that any single device failure will not disrupt or halt bus communications. Provide line voltage input protection to all network level controllers to protect these devices from over-voltage and lightning strike conditions.

E. A service representative of the installer shall check the instrumentation for proper installation, calibrate all instruments and make all adjustments necessary to insure proper operation of the system in full cooperation with the Testing, Adjusting, and Balancing (TAB) Firm. Refer to Section 23 05 93. All instruments required for checking, calibrating, and proving the system shall be provided under this Section of the Specifications. The service representative shall spend sufficient time with all of the Owner's Representatives after the system is installed and properly functioning to instruct the Owner's Representative (Operations and Maintenance Personnel) in the operation of the system for a minimum of sixteen (16) hours for the basic Controls System and twenty-four (24) hours for the EMS. At final completion of the installation provide personnel and instruments of satisfactory quality available to check the calibration of all instruments, and to demonstrate system operation as described in "Sequences of Operation".

F. All basic control devices, parts, and other materials, shall be standard catalog products of a single reputable manufacturer and shall essentially duplicate equipment which has been in satisfactory service for at least one (1) year. All materials and parts shall be items in current production by the manufacturers. First of a kind new technology devices will not be considered. Accessory equipment that is required to make a complete and functioning system that is not of the same manufacturer furnishing the basic control equipment shall carry the guarantee of the basic control equipment manufacturer and repair and replacement parts shall be available through normal local trade channels.

G. All software updates and enhancements which evolve during the first year warranty period following system acceptance, "Substantial Completion", shall be furnished to the Owner without additional cost. This shall include the local stand-alone direct digital controllers and the building network manager computer(s).

H. All network level controllers shall be either native “ASHRAE BACNET” or LON Mark and shall communicate with all other BACNET or LON Mark Protocol communication systems at the building network level or be provided with a gateway which shall facilitate the building network level controller communicating with one of these systems.

1.4 SYSTEM START-UP AND COMMISSIONING

A. After completion of the installation, Contractor shall place the system in operation and shall perform all necessary testing and debugging operations of the basic systems and EMS.

B. An acceptance test shall be performed in the presence of the Testing, Adjusting, and Balancing (TAB) Company, to verify correct sequences of operation, calibration, and operation of the Controls and Energy Management System, when installed, with every part of the system functioning satisfactorily and having been fully commissioned, and with no outstanding items requiring completion or correction, the system will be accepted by the Architect and Owner for "Substantial Completion", and will then be placed under Warranty.

C. The Automatic Temperature Control and Energy Management System Installer shall thoroughly check all controls, sensors, operators, sequences, etc., before notifying the TAB Agency that the Automatic Temperature Controls and Energy Management System are operational. The Automatic Temperature Control and Energy Management System Installer shall provide technical support (technicians and necessary hardware and software) to the TAB Agency to allow for a complete check-out of these systems.

1.5 SUBMITTALS

A. Submittals shall be complete and be in full accordance with Section 23 05 00, Common Work for HVAC.

B. Submittals shall include complete, continuous line, point to point wiring diagrams including tie-in points to equipment with written sequences of control adjacent to pertinent control diagrams. Specification sheets shall be submitted on each piece or type of equipment in a separate brochure and show sufficient detail to indicate compliance with these specifications. Drawings and Specification sheets shall show set points, throttling ranges, actions, proportional bands, and integration constants, where applicable. Complete brochures shall include the wiring diagrams as well as operating and maintenance instructions on the equipment.

C. Complete and approved shop drawings shall be obtained prior to commencing installation work, unless otherwise approved by the Owner or Owner's Representative.

D. Tag numbers, as shown or specified, shall appear for each item on the wiring diagrams and data sheets. Data sheets shall properly reflect in every detail the specific item submitted.

E. After completion of the work, Contractor shall prepare and furnish maintenance brochures for the Owner. The maintenance brochures shall include operating instructions, specifications, and instruction sheets for all instruments and a complete set of "As-Built" control drawings. After approval of submittal, completion of all installation work, software checkout, and system commissioning in conjunction with the Testing, Adjustment and Balance (TAB) Firm, furnish to the Owner the following:

1. Three (3) sets of Blue or Black line prints of "As-Built" drawings, half size (11" X 17"), inserted in a three ring binder.
2. Three (3) copies of the final approved Shop Drawings in suitably sized three ring binders. This shall include copies of product data sheets and other operations and maintenance documentation.
3. A complete replacement spare parts list.
4. A back-up copy of the EMS settings and sequences of operation on a compact disc (CD). The CD shall include all of the files necessary to restore the EMS and controls systems to normal operation in the event of a system failure.
5. Two (2) labeled USB devices with all the information indicated above for items 1, 2, 3 and 4 in PDF format.

1.6 EMS SOFTWARE TOOLS AND LICENSES

A. Submit a copy of all software installed on the servers and workstations related to this project.

B. Submit all licensing information for all software installed on the servers and workstations.

C. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.

D. Submit all licensing information for all of the software used to execute the project.

E. All software revisions shall be as installed at the time of system acceptance.

1.7 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored, and which is damaged or defaced during construction shall be rejected.

B. Cover control panels, open ends of control piping and open ends of control valves stored on site until just prior to installation of wiring and valves respectively.

C. Storage and protection of materials shall be in accordance with Division 1.

PART 2 - PRODUCTS

2.1 TEMPERATURE SENSORS

A. Temperature sensors shall be nickel wire thermistor, 10,000 ohm resistance, or RTD Type, with 1000 ohms resistance at 70 Deg.F. and a 3 ohms/per degree F temperature coefficient. Sensors shall operate in a stable manner in a 5-95% relative humidity, non-condensing environment.

B. Ambient temperature limits shall be minimum of 0-125 Deg.F. with a +/- 0.5% accuracy at a nominal resistance equal to 70 Deg.F.

C. Temperature sensors and cabling used for temperatures below 60 Deg.F. shall be hermetically sealed to prevent condensation damage to conductors or elements. Sensors for immersion locations shall not be affected by vibrations encountered in normal piping systems.

D. Piping thermowells shall be furnished for each pipe or tank mounted temperature sensor. All wells shall extend to a minimum of the middle of the piping. Tank sensor wells shall be a minimum of 18" in length. Wells shall be single piece machined brass or stainless steel. Diameter of wells shall allow for the easy fit of sensors and shall have a minimum 1/2" internal threads and 3/4" external threads. Insert heat conductive paste in wells prior to placement of sensor. Wells shall be equal to MAMAC A-500 and thermal compound shall be equal to MAMAC A-505.

E. Mixed air temperature sensors shall be the averaging capillary type to sense duct temperature across the full duct width. Minimum sensor length shall be 15 feet and include adequate supports for element within the duct or at the face of the coil, maintain minimum one inch (1") separation from coil.

F. Furnish sensors with maximum 6 to 9 inch insulated pigtail leads or trim sensor pigtail leads to meet this criteria once installed.

G. All sensor actions shall be the same for the entire building.

H. Mount all room wall sensors at 48" inches above finished floor to comply with A.D.A., unless indicated or approved otherwise by the Architect or Owner's Representative.

I. Wall space temperature sensors for normally occupied spaces shall include the following accessories, features and functions:

1. Normal Increase/Decrease Temperature Setpoint adjustments; limits set through software.
2. Impact Resistant Lexan type cover material.
3. Local override pushbutton to energize controlled equipment.
4. Local operator interface communication service jack compatible with mobile trouble shooting terminal unit. Alternately, provide spare service jack on terminal equipment controller on controlled terminal equipment.

J. Wall space temperature sensors in Common Public Areas (Corridors, Lobbies, etc.) shall include the following accessories, features and functions:

1. Impact Resistant Lexan type cover material.
2. Local operator interface communication service jack compatible with mobile trouble shooting terminal unit. Alternately, provide spare service jack on terminal equipment controller on controlled terminal equipment.

K. Sensors shall be as manufactured by Johnson Controls, Inc.; Schneider Electric; Honeywell; Veris Industries; or Reliable.

2.2 RELATIVE HUMIDITY SENSORS

A. Provide a 100% solid state copolymer wafer, of bonded layer hygrometric materials, humidity sensor and transducer. Sensor shall require no periodic maintenance or recurring calibration. Sensor shall be linear and temperature compensated.

B. Sensor shall have +/-2% Relative Humidity (RH) accuracy over a 100% RH range and +/-1% over the 30-80% RH range.

C. Sensor shall produce outputs of 4-20 ma or 1-11 vdc.

D. Sensor shall be in an impact resistant cover with ventilating openings in occupied spaces. Provide duct or remote mount probes as required for the application.

E. Wall mounted sensors shall be mounted 48 inches above finished floor to comply with A.D.A., unless indicated or otherwise approved by the Architect or Owner's Representative.

F. Acceptable Manufacturers:

1. Veris Industries.
2. Reliable.
3. Schneider.

2.3 CARBON DIOXIDE SENSORS

A. Furnish and install “CarboCap” technology (Vaisala) or Single Beam, dual wavelength, Infrared type technology (Tel-Aire) carbon dioxide sensors where indicated and as specified elsewhere herein.

B. Sensors shall accurately sense carbon dioxide levels from 250-2000 Parts Per Million (PPM) with an accuracy of + 60 ppm (+ 2% of range (2000 PPM) and + 2% of reading (use 1000 PPM)), repeatability of + 2% of full scale, maximum drift of + 5% of full scale in five (5) years, + 1% of full scale in six (6) months, and linearity of less than + 3% of full scale.

C. Sensors shall be suitable for operation in environments of 60 Deg.F. to 104 Deg.F. and 15-95% relative humidity, non-condensing, and air velocity ranges of 200 to 2750 feet per minute when located in ductwork. Wall mount sensors shall be able to sense accurately with air velocities as low as 20 feet per minute.

D. Sensors shall be calibrated at the factory at 1,000 PPM, + 50 PPM; at 72 Deg.F, + 4 Deg.F.; and at 50% relative humidity, + 5%.

E. Power requirements shall be 24 colts AC with a power consumption not to exceed 5 watts.

F. Wall mount sensors shall be mounted at 48-54 inches above the finished floor.

G. Sensors shall be as manufactured by:

1. Vaisala, Model GMD/W20 or equals by;
2. Tel-Aire(Model 8101/8102), or
3. Alternate equal models by Veris Industries.

2.4 COMBINATIONS SENSORS

A. Where two (2) and three sensors, such as temperature, relative humidity or carbon dioxide, are all located in the same location, a combination sensor shall be used.

B. Submit combination sensors for review and approval. Devices similar to the Veris Industries “CWL SHTA” are preferred and are acceptable.

2.5 CARBON MONOXIDE SENSOR AND ALARM (BOILER ROOM)

A. A carbon monoxide detector shall be installed in the Boiler Room as shown on the.

B. The carbon monoxide detector shall be similar to Greystone Energy Systems, Inc. model CMD5B.

C. The carbon monoxide detector shall have the following features and functions:

1. The carbon monoxide alarm shall utilize an electrochemical sensing element with an expected 5-7-year life.
2. Sensor shall be space mounted on the wall.
3. The carbon monoxide alarm shall be calibrated in accordance with ANSI/UL 2034 requirements to alarm at 50 PPM CO for 1-4 hours, 150 PPM CO for 10-50 minutes, and 400 PPM for 4-15 minutes.
4. The alarm shall have a battery back-up in the even that building power is lost. Battery impedance shall be verified by the circuit of the CO alarm. The CO alarm shall provide an indicator when the battery is low in power or high impedance or is missing.
5. The CO alarm will provide an audible indicator of 3 quick chirps every 30 seconds at the end of life of CO sensor.
6. The CO alarm shall be a solid state piezo alarm rated at 85dBA at 10cm.
7. Provide relay contacts with 4-20 mA signal or BacNET interface port to accomplish control sequence.
8. Accuracy shall be +/- 5PPM or 5% of reading.
9. Operating conditions shall be from -4 Deg F to 122 Deg F temperature and 15 to 95% RH relative humidity.
10. An easily accessible test button shall be provided to indicate functionality of the sensor.
11. The device shall have auxiliary relay contacts for initiating remote functions and annunciation.
    a. The device shall be installed such that it sends a signal to the EMS for alarming purposes.
    b. The device shall be installed such that it is provided with two (2) relays that are hard wired to the boilers (one per boiler). Each relay trip shall be set to 50 PPM.
12. The device shall be UL 2034 and 2075 listed.

2.6 SMOKE DETECTORS

A. One (1) smoke detector shall be furnished under Division 26 and installed by the Fire Alarm Contractor for each new air handling equipment item handling over 2,000 CFM of airflow; to be mounted in the return air stream, which shall stop the fan motors upon detection of smoke.

B. Coordinate with Division 26 requirements to insure sampling tubes are provided suitable to the width of duct in which installed.

C. Detectors shall be supplied with 24 volts, power supply under Division 26. Control circuit interlock wiring shall be installed by fire alarm contractor under Division 26. Controls Contractor to provide wiring to unit. Fire alarm Contractor to provide wiring to smoke detector or panel.

D. Acceptable duct detectors, where not specified elsewhere, shall be THORN-DH-22, BRK-DH2851AC, or Gamewell MS-69433, suitable for single station operation.

2.7 AUTOMATIC CONTROL VALVES

A. Valves 1/2" up to 2" in size shall have hardened and polished stainless steel stems, brass plugs (globe type) and have spring loaded cone packing rated for a maximum fluid temperature of 280 Deg. F. Globe valves shall have screwed cast brass bodies with a body rating of 150 PSIG at 250 Deg.F.

B. In lieu of globe valves, only in sizes from 1/2" to 3", electronic characterized ball control valves may be used. Characterized ball valves shall have a forged brass body with stainless steel stem, stainless steel ball, fiberglass reinforced Teflon seals (PTFE), have a “Tefzel” characterized disc, two (2) EPDM packing O-rings and be suitable for pressures up to 400 PSI and temperatures from 0-212 Deg.F.

C. All control valves 3 inches and larger shall have flanged iron bodies with a body rating of 150 PSIG at 250 Deg.F. and be the globe type only.

D. Control valves shall be sized for full flow with a maximum pressure drop of 4.0 PSI for fan coil units, VAV terminal units, duct mounted water coils, and air handling units handling less than 6500 CFM and 5.0 PSI for air handling units with a capacity of 6500 CFM and over. Control valves with flow rates of 2.0 GPM, or less, shall be sized for a maximum pressure drop of 2.0 PSI.

E. Two position valves shall be line size.

F. Two and three way valves, modulating type only, shall not be dual butterfly arrangement in sizes 6" and below. Valves 6" and below shall have single contoured plugs, globe style, made of brass or stainless steel construction for metal to metal seating. Valves 2 inches and smaller shall have screwed cast brass bodies with a body rating of 150 PSIG at 250 Deg.F. Valves 2" and smaller may also be characterized ball type valves.

G. Butterfly type valves, used for control, over 6" only, shall have tight sealing gasketing in contact with the wafer suitable for end of line pressure shut off, bubble tight, and shall have single piece bodies; i.e., two (2) separate butterfly valves are not acceptable as a three-way valve. Three-way butterfly valves shall consist of a single cast iron flanged tee.

H. All valves shall have tight closing seats and be of the equal percentage type for two-way valves and be the linear type for three-way valves.

I. All control valves shall have packing and seating materials that are compatible with ethylene glycol where glycol is being used, up to a 50% glycol water mixture.

J. Valves shall be as manufactured by

1. Johnson Controls, Inc.
2. Honeywell, Inc.
3. Siemens.
4. Belimo.
5. Keystone (Butterfly type only).

2.8 AUTOMATIC DAMPERS

A. Provide all control dampers, under this Section of the Specifications, of the types and sizes indicated on the Drawings, including but not limited to outside air intakes, return, relief, and other motorized air control dampers where shown, or where not an integral part of the equipment furnished and specified in other sections of these specifications. All dampers shall be special low leakage extended performance type.

B. Damper frames shall be not less than 16 gauge galvanized steel formed for extra strength with mounting holes for flange and enclosed duct mounting.

C. Dampers shall be available in two-inch size increments from 8" horizontal and vertical to 48". Requirements for dampers over 48" in size shall be met by using standard modules with interconnecting hardware to limit damper blade length to a maximum of 48". Provide separate actuator for damper modules exceeding 32.0 square feet and as required for smaller sizes due to torque requirements.

D. All damper blades shall be not less than 16 gauge galvanized steel roll formed for high velocity performance. Blades on all dampers must be not over 6" wide.

E. Blade bearings shall be nylon or oilite with 1/2" zinc plated steel shafts.

F. All blade linkage hardware shall be of corrosion-resistant finish and readily accessible for maintenance after installation.

G. Provide continuous replaceable neoprene or butyl rubber edging seals for all outdoor and relief air dampers where blade edges meet when dampers are closed. Spring loaded stainless steel side jamb seals shall be provided for all dampers.

H. Dampers and seals shall be suitable for temperature ranges of -20 degrees F to 200 degrees F at specified leakage ratings.

I. Dampers used for proportional control shall have opposed blades.

J. Leakage rates for all controlled dampers shall not exceed 5 CFM of air flow per square foot of face area based on a 16 square foot damper, at 1.0" W.C. differential, rated in accordance with AMCA 500. Furnish test data with submittals.

K. Acceptable manufacturers (No other manufacturers will be allowed):

1. Johnson Controls, Inc.
2. Honeywell, Inc.
3. American Warming and Ventilating, Inc.
4. Ruskin.
5. Nailor Industries, Inc.

2.9 ELECTRIC DAMPER AND VALVE ACTUATORS

A. All control valves and dampers shall receive electric actuators.

B. Electronic direct-coupled actuation devices shall be provided.

C. Electric Actuators shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and to eliminate slippage.

D. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jack shaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable.

E. Actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

F. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. This applies to all dampers directly connected to outside and relief air systems. Heating water valves serving coils on air handling equipment directly connected to an outside air intake shall have spring return. All spring return

actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation.

G. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. Floating point type control is acceptable on fan coil units, unit heaters and variable air volume terminals. All actuators shall provide for a 2 to 10 VDC position feedback signal although not used at this time. However, software feedback will be used at this time.

H. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA.

I. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper or valve when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

J. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation. Modulating actuators shall be compatible with the PWM output of the direct digital controllers.

K. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

L. Actuators shall be Underwriters Laboratories Standard 873 listed.

M. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a minimum 2-year manufacturer's warranty, starting from the date of Substantial Completion.

N. All actuators connected to all sequenced valves and dampers shall have independent control and adjustment from one another to emulate a pilot positioner.

O. Acceptable Manufacturer's:

1. Belimo.
2. Honeywell, Inc.
3. Johnson Controls, Inc.
4. Siemens.
5. Honeywell, Inc.

2.10 AIR FLOW MEASURING SYSTEM

A. Furnish and install air flow measuring systems at the locations indicated on the Drawings or where specified elsewhere herein.

B. The air flow measuring system shall be of the thermal dispersion type.

C. Provide one air flow measuring device (AMD) for each measurement location indicated on the Drawings or where specified elsewhere herein to determine the average air flow rate and temperature at each measurement location.

D. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.

E. Duct Mounted Sensors

1. Sensor probe assembly shall be a minimum of 8" x 8" with type 304 stainless steel mounting brackets.
2. Sensor shall have a maximum of 4 probes per transmitter; 4 sensing nodes per probe; and 16 nodes total. Sensor shall have a calibrated range of 0 to 5,000 FPM and have a minimum accuracy + 2% of reading over this range.

3. Probes shall be constructed of type 6063 gold anodized aluminum and have 10 foot plenum rated FEP cables.
4. Transmitter shall be constructed of industrial grade grade IC's and have an aluminum chassis with a sliding cover. Provide an RS-485 output to the Building Energy Management System (EMS) to allow for outside air flow quantity in cubic feet per minute (CFM).

F. Monitoring devices shall be rated to operate over a temperature range of -20°F. to 160°F. and a humidity range of 0% R.H. to 99% R.H.

G. All sensors shall be tested in accordance with AMCA Standard No. 610-93, Airflow Station Performance, at an AMCA certified laboratory.

H. Pressure Drop in an assembled unit shall not exceed 0.04 Inches W.G. at 1,000 feet per minute.

I. Acceptable Manufacturers:

1. Ebtron.

2.11 CURRENT SENSING STATUS RELAYS

A. Provide current sensing status relays for motor operation status monitoring as specified elsewhere herein.

B. Sensors shall be 100% solid state, no mechanical parts, and have no calibration drift.

C. Sensors shall have an adjustable trip level, be isolated, have single set point adjustment, require no external power (power induced from conductor), and have integrated adjustable wall or floor mounting bracket.

D. Sensors shall be suitable for motor loads from 0 to 100 HP, with a supply current of 1 ampere up to 135 amperes, 600 VAC RMS, setpoint adjustable to +/-1% range from 0-95% non-condensing relative humidity

E. Sensors shall be as manufactured by Veris Industries, Inc.

2.12 WATER FLOW SENSORS AND TRANSMITTERS

A. Provide an Onicon bi-directional insertion type electromagnetic flow sensor.

B. Use a low impedance 8VDC signal to transmit at a frequency proportional to the flow rate. Signal shall travel up to 2,000' between the sensor and the display unit without the need for amplification. Sensors shall be supplied with 10' of Belden type 9320 (two conductor shield) cable.

C. Provide Onicon Model F-3500 electromagnetic flow sensors. Sensors shall mount in a 1" NPT pipe saddle or Threadolet using positioning nuts on three threaded retaining rods. Insertion depth shall be a minimum of 1-1/2" inches in the pipe with a minimum of 10 upstream and 5 downstream straight pipe diameters of uninterrupted flow. An accuracy of +/- 1% of actual flow rate shall be obtained between flow velocities of 0.1 to 20feet/second.

D. Sensor design parameters shall be as follows:

1. Accuracy:	+/-1% of full scale.
2. Linearity:	+/-1%
3. Repeatability:	+/-0.3%
4. Rangeability:	+/-200:1
5. Flowrate:	0.1-20 feet/second
6. Maximum Pressure:	200 psi maximum
7. Maximum Temperature:	250 Deg.F.
8. Wetted Materials:	
Wetted Metal Components:	316 Stainless Steel
a. Sensor Head:	XAREC
b. O-Rings:	Ethylene propylene (EPDM)
c. Sleeve:	316 Stainless Steel and Hex adapter.

E. Provide an Analog Flow Transmitter, without a visual display of flow rate, to interface with the automation system. The analog output transmitter shall be a frequency-to-analog converter designed to operate in conjunction with non-magnetic insertion flow sensors.

F. The transmitter shall allow the user to select any one of four analog output signals including a 4-20 ma current output or three voltage outputs, (0-1V, 0-5V, or 0-10V). Output signal shall be directly proportional to the flow rate.

G. Each end of the analog range shall be set independently so that the analog range can bracket a specific flow range to increase the resolution of the output.

H. Transmitter design parameters shall be as follows:

1. Operation Temperature Range:	From 0 to 55 Deg.C.
2. Storage temperature Range:	From -40 to 70 Deg.C.
3. Power requirements:	120 VAC, 60 Hz.
4. Linearity:	Better than 1%
5. Output response time:	6 seconds; 10% to 90% step response
6. Designed Output Ripple:	Less than 0.25% of full scale
7. Outputs:	4-20 ma (22V compliance); 0-5 Volt; or 0-10 Volt

2.13 WATER PRESSURE SENSORS AND TRANSMITTERS

A. Sensors shall be variable capacitance type made from a one-piece stainless steel body and an insulated electrode plate.

B. Materials exposed to the wetted media shall be solid 17-4 PH stainless steel.

C. Sensor shall be free of welds, seams, or O-Rings.

D. Provide an electrical output of 4 to 20 ma for easy interface directly into the specified Direct Digital Control System. Sensor and transmitter shall be designed to meet ISA-S50.1 (1975) standard "Compatibility of Analog Signals for Electronic Industrial Process Instruments", Type and Class 2U (Universal).

E. Sensors shall be temperature compensated for low ambient thermal error.

F. Sensor accuracy shall be 0.11% of full scale at constant temperature.

G. Design parameter shall be as follows:

1. Non-linearity	Less than +/-0.1% full scale
2. Hysteresis:	Less than 0.05% full scale
3. Non-repeatability:	Less than 0.02% full scale
4. Thermal Effects:	30 Deg.F. to 150 Deg.F. range
5. Zero Shift, % full scale:	Less than +/-0.015%
6. Span Shift, % full scale:	Less than +/-0.01%
7. Temperature:	0 Deg.F. to 175 Deg.F. operating; 65 Deg.F to 250 Deg.F. storage

H. Sensors shall be a Setra Model C-280E Series designed for electrical connection to a two-wire circuit by simple screw termination. An equal model by Dwyer is acceptable.

2.14 FREEZESTATS

A. Freezestats, for freeze protection, shall be capillary tube type with minimum 20 foot long sensing element, sensitive to the coldest temperature along any 12 inch long portion, to de-energize equipment on a drop in temperature below setpoint.

B. Freezestats shall be field adjustable from a minimum of no lower than 35 Deg.F. up to 65 Deg.F. Standard setpoint shall be 40 Deg.F., unless noted otherwise. Provide dual temperature setpoint scale.

C. Freezestats shall be manual reset, unless indicated otherwise, and be rated for 120 VAC, maximum 10.0 amperes. Provide one (1) normally - open and one (1) normally - closed contacts. Provide an additional set of dry contacts on each device for connection to a central control and monitoring system.

D. Sensor and controller shall be able to operate in ambient conditions from 20 Deg.F. to 104 Deg.F. in a dust-proof and moisture-proof enclosure.

E. Provide mounting bracket suitable for mounting on ductwork and the side of air handling equipment.

F. Provide grommets for protection of capillary where inserted through drilled openings in equipment or ductwork.

G. Provide capillary tube stand-off brackets suitable to hold sensing element off of water coil fins to secure element firmly in place, as well as to avoid close contact with coil tubes.

H. Freezestats shall be as manufactured by Johnson Controls, Inc.; Honeywell, Inc.; Invensys: Siemens; or Robertshaw.

2.15 AIR FLOW DIFFERENTIAL PRESSURE SWITCHES

A. Air flow differential pressure switches shall be provided to verify operating status of air moving equipment, where specified elsewhere herein, to sense flow in air ducts, and to detect clogged air filters and to monitor space pressurization, unless specified in other sections of these specifications. These shall also be used to sense differential pressure in the space.

B. Switches shall be capable of operating in ambient temperatures from 0 Deg.F. to 165 Deg.F.

C. Setpoints shall be field adjustable from 0.05 to 5.0 inches water column to suit the application. Provide concealed scale plate with adjusting screw for setpoint adjustment. Scale shall be selected such that the normal operating range is at the midpoint of the scale; i.e. an operating range of 0.30 to 0.70 needs a scale of 1.0.

D. Materials of Construction:

1. Buna-N Diaphragm
2. Molded polycarbonate enclosure.
3. Zinc plated cold rolled steel; 0.040 inches thick for diaphragm housing and 0.032 inches thick for cover material.

E. Provide appropriate mounting brackets and any remote mounting probe kits as necessary for each particular mounting condition.

F. Acceptable Manufacturers:

1. Johnson Controls, Inc.
2. Honeywell, Inc.
3. Invensys.
4. Siemens.
5. Robertshaw.
6. Dwyer.

2.16 WATER FLOW DIFFERENTIAL PRESSURE SWITCHES

A. Water flow differential pressure switches shall be provided to verify operating status of all pumps, loss of water flow, and flow status for other equipment, such as chillers, evaporators, water cooled condensers, and other similar equipment.

B. Switches shall be heavy duty type capable of operating in ambient conditions from 32 Deg.F. to 104 Deg.F. for indoor applications. Where switches are used outdoors, suitably rated devices shall be used. Maximum differential pressure rating shall be a minimum of 50% above the normal system operating pressure differential. Switches shall be rated for 300 PSI and 300 Deg.F. service.

C. Provide one (1) set of main contacts with one (1) set of auxiliary contacts in a dust protected enclosure. Enclosure shall be moisture protected where used outdoors.

D. Case and cover shall be made of cold rolled steel; case shall be 0.062 inches thick minimum; with the cover painted and 0.028 inches thick minimum; or anodized cast aluminum. Material exposed to flow stream shall be brass, bronze or stainless steel material.

E. Switches shall be rated for the voltage of the circuit to which connected, and shall be minimum 120 volt rated for up to 6.0 amperes. Provide magnetic switching with a sealed tube of stainless steel isolating the switch compartment from the liquid and pressure within the piping system.

F. Switch action shall be suitable for the intended purpose, and shall be manually reset.

G. Differential pressure range shall be suitable for the application which shall typically be 2 to 26 PSI, or 2-30 PSI with a 1.2 or 2.0, respectively, fixed switch differential. Setpoint shall be field adjustable.

H. Provide all mounting brackets and accessories for a complete installation up to the shut-off devices furnished under Section 23 21 13.

I. Acceptable manufacturers:

1. Johnson Controls, Inc.
2. Honeywell, Inc.
3. Invensys

4. Siemens.
5. Robertshaw
6. McDonnell & Miller
7. Dwyer.

2.17 DIFFERENTIAL WATER PRESSURE SENSORS (TRANSDUCERS)

A. Differential Water Pressure Sensors (Transducers) shall be provided where indicated and as required to effect the sequences of operation as specified elsewhere herein.

B. Sensors shall be all stainless steel construction and be a 100% solid state transducer with dual diffused piezoresistive sensing elements with stainless steel media isolation.

C. All media exposed to the water shall be compatible with the water and chemical treatment added thereto.

D. Sensors shall generally be applied to sensing pump differential pressure and for other applications as specified.

E. Sensors shall not be sensitive to surge, water hammer, vibration or thermal shock from equipment and pipe mounting.

F. Sensors and related components shall be mounted in a easily accessible NEMA 1 enclosure.

G. Provide output signal compatible with control system installed and have a direct or reverse acting signal output option.

H. Provide an electronic averaging or snubbing option as required for the application to provide for stable operation or signal.

I. Sensor shall have a pressure range suitable for the application and have an accuracy of + 1%, linearity, repeatability and hysteresis of + 0.1%, be rated for temperatures of 0-180 Deg.F and have a differential pressure capability of 200% of the rated range.

J. Sensors shall be as manufactured by:

1. MAMAC PR-282 or equals by
2. Johnson Controls, Inc.
3. Honeywell, Inc.
4. Invensys.
5. Siemens.
6. Veris (P.W. Series).
7. Dwyer

2.18 LOCAL CONTROL PANELS

A. New local equipment control panels shall be installed in each equipment room, or other locations as indicated or as required, for new electric control equipment and control devices. They shall be totally enclosed, pre-piped, and wired to labeled terminals to house all associated controllers, thermometers, relays, switches, etc. serving that equipment. Provide one cabinet for each air handling unit or group of units in the same room.

B. Panels shall be mounted at a convenient height for access. Acceptable locations include mechanical equipment rooms, storage closets, electrical rooms, or other spaces as indicated on the Drawings. Above ceiling locations are not acceptable.

C. Thermometers, pilot light switches, and gauges shall be flush mounted on panel surface, where applicable.

D. Cabinet frames shall be extruded aluminum sections with riveted corners supported by internal angle brackets. Door shall have continuous hinged door, with latch and key lock.

E. Sub-Panel and face panel shall be removable for ease of installation and replacement. Face panel shall be of a finished color with a finished frame.

F. Knockouts for 1/2" x 3/4" EMT connections shall be provided at top and bottom of each panel.

G. Identify each panel, switch, and device by an engraved, bolt-on, black phenolic nameplate with white lettering securely attached. Identify all control devices inside panels similarly. Embossed plastic tape will not be acceptable on panel front faces but will be allowed on panel interiors.

H. Switches and pilot lights shall be mounted on the panel face with all other devices mounted inside the panel, as applicable. Devices wired through and inside panels, such as relays, shall be wired to numbered dual terminal strips.

I. Start-Stop Pushbuttons and Pilot Lights, where called for, shall be of the low voltage and neon type. Pushbuttons shall be heavy duty type. Pilot lights shall be interlocked with starter auxiliary contacts except fans and pumps which shall have current sensing relays to indicate run status.

J. Each new control panel installed shall have a minimum of 25% consolidated spare/extra space available inside the panel for mounting of control devices for future system modifications or changes. This space shall be indicated on the panel shop drawing.

K. All wiring inside panels shall be concealed in a wiring harness.

L. Permanently affix inside each panel a final "as-built" control drawing of the piping and wiring of the panel.

M. All panels shall be factory assembled, piped and wired and include a key cylinder lock. All locks shall use the same master key.

2.19 ENERGY MANAGEMENT SYSTEM

A. Where new central servers are required, provide system server as specified elsewhere herein.

B. Network Automation Engine:

1. Provide a Network Automation Engine (NAE) which shall be a fully user-programmable supervisory controller. Automation Engine shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Automation engines.
2. The NAE shall reside on the automation network. Each NAE shall support one or more sub-networks of a minimum of 100 controllers each.
3. Each NAE shall have the ability to deliver a web based user interface. All computers connected physically or virtually to the automation network shall have access to the web based User Interface (U.I.). Systems without such capability at this level shall provide a user interface via the combination of operator workstations and web servers as determined by the owner for comparable operation.
4. Processor-controllers shall be multi-tasking, multi-user, and real-time digital control/processors. Standard operating systems shall be employed. Controller size and capacity shall be sufficient to fully meet the requirements of this Section of the Specifications.
5. Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Each NAE controller shall have an integrated Hardware-Based, real time clock.
7. The NAE shall provide at least one USB port and one URS-232 serial data communication port for the operation of operator I/O devices, such as industry standard computers, modems, and portable operator’s terminals. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
8. Controllers shall continuously perform self-diagnostics, communication diagnostics, and diagnostics of all panel components. The automation engine shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failures to establish communication.
9. In the event of the loss of normal power, the NAE shall continue to operate for a user adjustable period of up to 10 minutes, after which, there shall be an orderly shutdown of all the programs to

prevent the loss of database or operating system software. Flash memory shall be incorporated for all critical controller configuration data.

a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.
b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

10. All NAE controllers shall be listed by Underwriters Laboratories (U.L.)."

C. Network Level Controllers shall have a 16 bit based microprocessor with EPROM operating system. DDC programs and data files shall be in non-volatile EEPROM or flash memory to allow simple and reliable additions and changes. Each network controller shall have an on-board 30 day battery back-up realtime clock. Controllers shall be provided as required with capacity to accommodate input/output (I/O) points required for the application plus any spare points as specified. Each panel shall be provided with a socket for a Portable Operators Terminal (POT), and a port for network communications at no less than 78,000 baud. Controllers shall have outputs which shall be binary for On-Off control, with true variable voltage (0-10v), for driving analog or pneumatic transducer devices. Analog outputs shall have a minimum incremental resolution of one percent of the operating range of the controlled device. Controllers shall have LEDs for continuous indication of all bus communications, power, and operational status. All panel electronics and associated equipment shall be installed in suitable enclosures.

D. Terminal Equipment Controllers (TEC's) shall be UL916 standalone EEPROM based and configured to perform the sequences specified, and with I/O selected for the application. TEC enclosures shall be compact plastic conforming to UL94-5V or plated steel. Each TEC shall be provided with LED type annunciation to continually display its operational mode; power, normal, or in an alarm state. TEC networks operating on a 9000 baud rate shall be grouped with no more than 20 TEC's per primary bus connected device. For TEC networks operating over 50,000 baud, up to 100 TECs may be so grouped.

E. Furnish and ship damper actuators and terminal unit controllers to the terminal unit manufacturer for factory installation. Refer to Specification Section 23 30 00 and Drawings for coordination details. Terminal unit manufacturer shall furnish transformers, relays, air flow rings, and all metal control enclosures. Under this Section of the Specifications, provide the terminal unit manufacturer with necessary wiring and mounting instructions.

F. General:

1. Software development and programming shall be as directed by the Owner and as described herein. Contractor shall install all program operating time schedules as furnished by the Owner. During construction, the Contractor may operate equipment in what is considered a Construction Schedule. The control systems installer, at Substantial Completion, shall remove such schedules and replace these with individual, independent, operating schedules for each system and individual piece of equipment, specifically air handling equipment.
2. Program trend logging of all analog and binary points of control at intervals as directed by the Owner, initially use five (5) minutes for all control points.
3. Overall systems control shall be performed by a field programmable direct digital controller, microprocessor based, which incorporates Direct Digital Control, all necessary energy management functions and provides for digital display and convenient local adjustments of desired variations at each individual controller cabinet. This shall include scheduled programming and system interlocks.
4. DDC control units and all hardware shall be capable of continued operation at room temperatures of 40 Deg.F. to 120 Deg.F. and humidity from 10% up to a non-condensing point of 90%. All inputs shall be capable of withstanding continuous shorting to 120 VAC.
5. Provide any external electrical power supply protection devices to protect controllers from external voltage surges to include high voltage and lightning disturbances/protection.
6. Provide function switches in a local control panel, if not integral with the DDC controller, with "on-off" control and a "manual-auto" switch for each new DDC output (contact type) with switch status information being available to the central systems historical data files for all air handling units, fan coil units over 2000 CFM in capacity, pumps, chillers, controlled exhaust fans over 2000 CFM in

capacity and boilers. Alternately, provide this capability integral with the Direct Digital Controllers. Terminal units such as Variable Air Volume boxes, small exhaust fans, small fan coil units, and rooftop A/C units are not required to have function switches. Switches shall be concealed within the local control panel or digital controller enclosure to be lockable. The network manager software shall identify points that are locally overridden and report by display to the building CPU to include generating a printout at the local or remote location printer.

7. Provide a hard wire connection between the Building LAN serving all new Controllers to the Central Facilities Energy Management System. Verify dependable utilization of this system and transfer of local system data and functions to the control system CPU. General data reporting and alarms transmission shall be verified.
8. Provide a new computer terminal in the Building as required. Computer shall be used for digital parameter display, programmed to display analog variables, binary conditions, off normal scans and other analog or binary information required for analysis and adjustment of the system being controlled. Computer shall further contain display features to indicate automatic operation, manual or override operation, alarm indication, and other auxiliary displays associated with special purpose auxiliary function keys.
9. The associated keyboard shall contain all alphanumerical keys to call-up the desired points and type of value to be displayed and have several special dedicated keys for such functions as manual-auto, test and function and value enter, as an aid to the operator. A minimum of two keys shall be programmable for auxiliary functions that may be used frequently.
10. Energy Management System programs shall include, but not all are necessarily utilized, but shall not be limited to:

    a. Optimal start-stop using an adaptive algorithm to prevent the need for manual adjustments of parameters.
    b. Optimization programs controlling equipment using outdoor dry bulb and dew point temperatures. The outdoor wet bulb temperature shall be calculated by the following equation:
       WB = (DB-DP)K+DP where K = 0.560-0.0068 (DP-30)

G. Control:

1. Control algorithms shall be available and resident in the digital system controller to permit Proportional, Integral, and Derivative control modes in any combination to meet the needs of the application. Other control modes such as incremental, floating, or two-position must be available to adapt to job needs.
2. All control shall be performed in a digital manner using the digital signal from the microprocessor based controller converted through electronic circuitry for modulation of electric actuators.
3. Provide sensitivity adjustment for all DDC output control points.
4. The library of routines available in firmware must be capable of generating additional programs as may be required for specific client tailored requirements. The Owner shall be capable of revising programs without the aide of the installer.
5. Adjustments of all new control variables shall be conveniently available at the computer terminal through the use of the keyboard and display. The adjustments shall include, but not be limited to, proportional gain, integral rate, the velocity and acceleration constants associated with incremental control and on/off values of two-position control.

H. Field Programmable:

1. The local DDC controllers shall each contain all necessary mathematic, logic, utility functions; and all standard energy calculations and control functions in ROM to be available in any combination for field programming the unit. These routines shall include, but not be limited to:

    a. Math Routines:
    b. Basic Arithmetic
    c. Binary Logic
    d. Relational Logic
    e. Fixed Formulas for Psychometric Calculations

2. Utility Routines for:

    a. Process entry and exit
    b. Keyboard functions

c. Variable adjustments and output
d. Alarm Indication
e. Restart

3. Control Routines for:

a. Signal compensation
b. Loop control
c. Energy conservation
d. Timed programming

4. Final field programs shall be stored in battery backed up RAM or in permanent memory.

I. Expandability: The DDC shall be expandable by adding additional field interface units that operate through the central processor of the DDC. The processor in the DDC shall be able to manage remote field interface units thereby expanding its control loop and energy management point capacity. Remote units shall be able to stand alone and have two-way communication in a LAN configuration. Systems furnished shall be fully manufacturer supported and under current production.

J. Calibration Compensation: To maintain long term analog accuracy to the controller sensing circuits, the DDC shall sense the voltage being supplied to the resistance sensing element and through firmware compensate for power supply changes due to long term drift or drift due to ambient temperature changes at the power supply.

K. Battery Backup:

1. New DDC system controllers shall be supplied with a minimum of 48 hours of nickel-cadmium battery backup, during power outages, for the RAM, with an automatic battery charger to maintain charge while power is on, to prevent internal component damage or failure.
2. DDC modules shall have automatic restart capabilities with sequencing after a power failure without program interruption. All EMS controlled equipment with motor loads of one horsepower, or equivalent, and larger shall be started after power resumes in equal load groups in intervals of every 20 seconds, adjustable, to minimize electrical demand.

L. Associated Hardware:

1. All actuators for valves and dampers shall be supplied under this section of the specifications.
2. Where modulating electric actuators are used they shall be compatible with the (pulse width modulated) output of the Digital System Controller.

M. Diagnostics: The Digital System Controller shall contain in its program a self test procedure for checking the digital controllers, and by means of a non-destructive memory, check the computer.

N. Default Operating Procedure and Alarms:

1. All variables shall be identified as being reliable or unreliable. When a calculation is required to use a value (sensed or calculated), which is identified as being unreliable, the unreliable data value will flash. The calculation will use a default value programmed into the unit.
2. All alarms (a pump that did not start, etc.) and all deviation alarms (temperature, off, normal, etc.) will locally display an alarm as well as report to the CPU the type of alarm, designate equipment or system effected, date and time of alarm. A hard copy printout of alarms shall be generated at the CPU location. A scan can then identify all alarm conditions and their identifier.

O. Cabinet:

1. The DDC modules shall be enclosed in a metal frame cabinet. The cabinet shall be constructed such that it can be mounted and electrical terminations can be made during the construction phase of the project. The DDC electronics are to be removed and added at a later date, only prior to start-up.
2. Cabinet shall be installed on the wall in the Mechanical Rooms or elsewhere as indicated.
3. DDC cabinets shall be provided with a key lock. All cabinets on each installation shall utilize one master key.
4. All control wiring and system communications shall be electrically terminated inside DDC cabinets.

P. U. L. Approval: The DDC system panels shall be an approved U.L. System, with U. L. listing as a Signaling System.

Q. General software features of the CPU and field controllers, with sufficient internal memory, shall include the following as a minimum (although not all are necessarily used):

1. Start-Stop Functions
2. Optimized Start-Stop Control (warm-up and cool-down)
    a. Time Programmed Commands
    b. Normal occupancy
    c. Holiday
    d. Occupancy overrides
    e. Schedules shall be programmable up to one year in advance with system wide or global scheduling and local, point by point scheduling.
3. Duty Cycle Control
4. Night Setback/Setup
5. Electric Demand Limiting
6. Override Feature
7. Run Time Totalization with data in non-volatile module memory.
8. Provisions shall be made for on-line programming and override.

R. On/Off Points of System Control shall be provided for the following:

1. Pumps:
    a. Primary Chilled Water Pumps: PCHP-1 and 2.
    b. Secondary Chilled Water Distribution Pumps: CHP-1 and 2.
    c. Heating Water Distribution Pumps: HWP-1 and 2.
    d. Domestic Hot Water System Recirculating Pumps: None are to be controlled by the EMS.
2. Exhaust Fans:
    a. Toilet Exhaust Fans: EF-A206, A211, B3, B7, B111, C1 and C2.
    b. Electrical Rooms: EF-A1, B1, B5, B9, B10, C4, and C5.
    c. Riser Room: EF-B22.
    d. Crawlspace: EF-B19 and B20.
    e. IDF Rooms: EF-A205, B4, and B8.
    f. Kitchen Hood and Dishwash Hood Exhaust Fans (MeLINK interface and status only).
    g. Prep Rooms: EF-B18 and C3.
    h. Freezer/Cooler Ventilation: EF-B14.
    i. Dishwasher and General Kitchen Exhaust Fans (EF-B15, B16 and B17) (Status only for AHU activation).
3. Air Handling Units:
    a. Constant Air Volume Units: AHU-A2.
    b. Variable Air Volume Units: AHU-BG, A1, B1, B2 and C1.
4. Boilers: B-1 and B-2.
5. Chillers: CH-1 and 2.
6. Fan Coil Unit: FCU-C1
7. Rooftop AC Units: OAU-B1, additionally provide BacNET interface to the unit manufacturer furnished BacNET card.

S. Run Status (On/Off) of all units indicated above shall also be provided and shall be capable of being accessed for on-line programming. Status shall be by means of the local motor controller through the use of adjustable current sensing relays, using a current sensing relay on the evaporator fan motor for status on constant speed fan and pump motors for other air and fluid handling equipment. For motors operated with variable frequency drives use the status from the drive. Coordinate the means of status with all equipment furnished.

T. Failure Alarm Status for the following EMS controlled items shall be provided through the EMS:

1. Combined Safety Alarm, one (1) for each AHU, FCU, pump, chiller, boiler and each EMS controlled fan.
2. Dirty filter status for AHU's (i.e. high pressure).
3. Low/High Temperature Alarms for each temperature sensor installed, four (4) Deg.F. above or below set point, adjustable.
4. High Relative Humidity Alarm for each space and return air relative humidity sensor installed; on a rise above 65% R.H., adjustable.
5. High Carbon Dioxide Level Alarm for each carbon dioxide sensor installed, on a rise above 1300 Parts Per Million, PPM, adjustable.
6. High Carbon Monoxide Level Alarm for each carbon monoxide sensor installed in boiler room, on a rise above 50 Parts Per Million, PPM, adjustable.
7. Each Variable Frequency Drive-Fault Condition (Refer to Plans for quantity).
8. Emergency Overflow Condensate Pan (suspended A/C equipment located above ceilings or Roof-Top AC units) Moisture Detection/High Water Level Alarm: De-energize unit served and sends alarm to the EMS.
9. Kitchen Walk-In Cooler/Freezer High Temperature alarm, three (3) units.
10. Polar Ionizer failure alarm for each polar ionizer installed, minimum one (1) per unit.
11. UV light array failure alarm for each UV light array installed, minimum one (1) per unit.

U. Provide for two annunciation signals for each controlled A/C equipment item, one to indicate that the heating system is operational and one to do the same for the cooling system, to be used for graphic system schematic status.

V. Provide cumulative run time logging and indication for equipment noted in Paragraph "R", above.

W. Provide analog indication for the following:

1. For each AHU, provide indication for each of the following:

a. Supply air discharge temperature, Deg.F.
b. Return air temperature, Deg.F.
c. Mixed air plenum temperature, Deg.F.
d. Zone/space temperature, Deg.F. (single zone units only)
e. Cooling coil discharge air temperature (AHU-A2 only).
f. Pre-heat coil discharge air temperature (AHU-A2 only).
g. Supply duct system static pressure, Inches W.G., location as determined by the TAB agent (applies to VAV systems only)
h. Space humidity level, % RH (single zone units only except as noted below).
i. Outside air flow through the airflow monitoring station, CFM.
j. UV Light Array intensity, Watts, through a radiometer for the UV light array (AHU-A1 and C1 only).

2. For each Fan Coil Unit, provide indication for each of the following:

a. Space temperature, Deg.F.
b. Supply air temperature, Deg.F.
c. Moisture Detection/High Water Level alarm in emergency condensate overflow pan (ducted units only).
d. Mixed air temperature (ducted units only with outside air).
e. Space relative humidity, R.H (Instrument Storage only).

3. For each Rooftop AC Unit, provide indication for each of the following:

a. Supply air discharge temperature, Deg.F.
b. Zone space temperature, Deg. F.
c. Space relative humidity, % R.H.

4. For each Ductless Split AC Unit, provide analog indication of the following:

a. Space temperature, Deg.F. (For monitoring and alarm only).

b. Space Relative Humidity, % RH (For monitoring and alarm only).

5. Provide water temperature indication for the following:
   a. Primary chilled water supply temperature, one (1) for each chiller, Deg.F. (2 chillers total)
   b. Primary chilled water return temperature, one (1) for each chiller, Deg.F. (2 chillers total)
   c. Secondary chilled water supply temperature, Deg. F.
   d. Secondary chilled water return temperature, Deg. F.
   e. Heating water supply temperature, one (1) per boiler, Deg.F. (2 boilers total).
   f. Main heating water supply temperature, Deg.F.
   g. Main heating water return temperature, Deg.F.
6. Provide water flow measurement for the following:
   a. Primary chilled water bypass, GPM.
7. Provide indication of outside air temperature in Deg.F for this building.
8. Provide indication of outside are relative humidity in % R.H. for this building.
9. Provide feedback of variable frequency drive operating frequency, or speed, for drives serving the following equipment:
   a. Pumps CHP-1, CHP-2 (alternated).
   b. Pumps HWP-1, HWP-2 (alternated).
   c. All Air Handling Units (supply air fans): AHU-A1, AHU-A2-1 & A2-2, AHU-BG, AHU-B1-1 & B1-2, AHU-C1-1 & C1-2.
   d. Relief Air Fans: RF-A1, A2, BG, B1, B2, and C1.
10. For each unit designated to have a VFD as shown in the Paragraph above, provide indication for system static pressure for AHU's and system water pressure differential for distribution water pumps, where noted in the sequence of operation. Refer to sequence of operation for the locations where water distribution differential pressure sensors are required as well as the quantities. For other units that do not modulate the VFDs in response to pressure differentials, refer to sequence of operation for control of VFDs.
11. V.A.V. Fan Powered Terminals:
    a. Space Temperature, Deg.F.
    b. Cold Primary Air, CFM.
    c. Primary Air Supply Temperature, Deg.F. (Air Handling Unit Discharge Air Temperature, Deg.F.)
    d. Terminal unit discharge air temperature, Deg.F.
    e. Hot Water Valve Position, % open.
    f. Primary Air Valve Position, % open.
    g. Fan Status - On/Off.
12. Single Duct VAV Terminals:
    a. Space Temperature, Deg.F.
    b. Cold Primary Air, CFM.
    c. Primary Air Supply Temperature, Deg.F. (Air Handling Unit Discharge Air Temperature, Deg.F.).
    d. Terminal Unit Discharge Air Temperature Deg.F.
13. Space Temperature, Degrees F.:
    a. Main Electrical Switchgear Room.
    b. Mechanical Central Plant.
    c. Mechanical Rooms.
    d. Fire Riser Room.
14. Space Relative Humidity, Percent (%) R.H.:
    a. One (1) in Lower Lobby C001.

b. One (1) in Lobby A101.
c. One (1) in Lobby C101.
d. One (1) in Board Room.
e. One (1) in Corridor B101F
f. One (1) in Corridor B202

15. Return Air Carbon Dioxide Level, PPM, for all VAV AHU's.
16. Valve and Damper Position Feedback: On the graphical systems schematics CRT display provide indication of the valve and damper positions in % open; 25% open, 50% open, 75% open, etc. Program trend logs for **each damper and valve installed**.
17. Electric Service Meter Demand KW and Consumption in KWH. Provide metering device under Division 26 of the Specifications. Provide interface to make metering device compatible with the EMS under this section of the specifications. Provide BacNET IP interface to electrical meter.

X. Provide BacNET or ModBUS interface between all remote mounted variable frequency drives and EMS.

Y. Provide ModBUS or BacNET MS/TP interface to all new boilers.

Z. Provide BacNET MS/TP interface to OAU-B1.

AA. Provide BacNET MS/TP interface from the MeLINK kitchen hood control system (GF-B1, B2 and B3).

BB. Building Computer Software Management features

1. Provide minimum of 15 User Selectable Passwords with a minimum of three levels of access. Highest level provides system access, secondary level provides access for command to field devices only, lowest level provides monitoring capabilities only with no field control allowed. Password access will be logged with time/date stamp and associated user ID.
2. Provide a minimum of 16 Point Group Summaries with each point inclusion selectable by system operator. Summaries will have a minimum of six (6) character identifiers for each group. A separately selectable All Points Summary shall be available to the operator for a view of the complete system. Alarm Summaries, listing all points in an alarm status shall be provided, and shall be Owner definable.
3. Trend logs and summaries:

    a. The Central Computer Workstation (CPU), shall be provided with, as a part of this contract, the ability to periodically trend any hardware, software, or simulated point within any of the attached DDC panels, for this project, at an Owner selectable interval of a minimum of once per second, up to at least once per 1000 minutes.
    b. The trending programming for selected points and all feature attributes of these points shall be accomplished online at the CPU with no disruption of dynamic communication with the remote DDC panels. The operator shall be able to add, delete, and modify points and attributes at any time while online. Online programmable attributes shall include:

        1) Point addition, deletion, and modification
        2) Sampling intervals and ranges
        3) Historical samples to be stored per individual point
        4) Dynamic data values
        5) Engineering units of each point

4. Online editing capabilities shall be provided for, but not limited to the following:

    a. Add/Delete Points
    b. Modify Engineering Units
    c. Modify/Create Point Groups
    d. Adjust Set Points
    e. Adjust Individual Start/Stop Times
    f. Trend Selected Points
    g. Observe Any System Point, Hardware, or Software
    h. This editing capability shall be for both CPU resident programs and remote DDC panel programs.

5. English language shall be used for all inputs, outputs, and display. Code or computer language will not be acceptable.
6. Remote DDC Field Communication: Communication between the Central Computer Workstation and the remote DDC panels shall be achieved via digital transmission utilizing a distributed polling technique for recognition of all field points, both software and hardware points status, issuing of commands, programming of DDC units, etc. Additionally provide software for the existing Central Computer to allow the same interaction/communication features as noted for the Computer Workstation Building. Data transmission shall be via hardware connection compatible with electric category Type 3002, as described in Bell System Technical Publications for Data Transmission using the highest Baud Rate reasonably possible.
7. New field panels/controllers shall be able to communicate with the existing front end system same as currently exists.
8. CRT Format:
    a. The CPU CRT format shall include and display in an individually dedicated and protected area of the viewing screen the following Dynamic information:
        1) The current time, date, and day of week (including Holidays).
        2) Sequential, as occurred, alarms.
        3) Visual indication of alarm or off normal conditions which are active.
        4) Current operator identification.
        5) Operator work area to display various forms of point information issue commands, and data base information relevant to current activities.
    b. Operator will have full access to the system for issuing commands, etc. while this display is active.
9. Provide a graphic software package and programming to result in a schematic illustration for each controlled piece or group of pieces, of equipment to illustrate all related controlled variables, set points and operating parameters. Additionally provide a building floor plan with room numbers and locations of all space sensors and controlled equipment. The user shall be able to click on any feature to pull up related system graphics.

2.20 WEB BROWSER INTERFACE

A. Provide Internet/Intranet Connectivity utilizing a Web Browser as follows:
    1. Shall be a “Server” based product that provides browser access to Ethernet enabled automation controllers. Access is accomplished by utilizing most recent version of Microsoft Edge or Google Chrome. No other “client” side software shall be necessary to view and utilize the system. The “Server” hosting the Web Application can be located anywhere on the Internet. The software functions by taking real-time data from the active automation systems and combining that information with the appropriate graphic file in an HTML format to be viewed by the web browser. The number of simultaneous users connected to the web application shall only be limited by the capability of the server hosting the application. The application should be able to service multiple sites.
    2. The graphics utilized for this system shall not require external applications to convert the images for use between the web server based application and the traditional graphical user interface. Graphics shall be interchangeable between applications.
    3. Web Browser Server shall receive server-based software which shall support Microsoft’s .NET standards for the exchange and interoperability of information and data.
    4. Server-based software upgrades shall be free to the owner for the first five (5) years the server is owned by the building Owner.
B. The Host Server at facilities building shall be reused.
C. The Web Browser Interface shall include the following user configuration requirements:
    1. Usernames and passwords can be setup via the Web Browser Interface. Physical access to the server is not required but will be password protected.
        a. Individual user names/passwords are to be utilized.

b. Usernames/passwords can be specifically unique to allow the user to be automatically redirected to a specific site, and or graphic display when logging into the system.

2. Passwords can be configured to allow the user to modify setpoints or not.
3. All user configuration functions shall be provided through an intuitive graphical user interface.
4. Web Browser Interface shall not require any external applications, “Client Side” software or “Plug-Ins” to connect, view, or control any aspect of the building automation system.
5. Access to the installed automation system shall be performed through Microsoft Internet Explorer.

D. Site Graphics shall meet the following requirements:

1. Graphics displayed through the Web Browser Interface must be the same graphic images provided through the Graphical User Interface described above. No external applications are to be required to interchange graphic images between the web server application and the graphical user interface.
2. Trend data must be able to be displayed graphically and in “spread sheet” format without the addition of any additional client side software, plug-Ins, or additional applications.
3. Digital Start/Stop Logging shall be able to be displayed and printed from the browser interface without the addition of any additional “client side” software, plug-Ins, or additional applications.
4. The display and printing of alarm data shall be performed without the addition of any “client side” software, plug-Ins, or additional applications.
5. Points that are manually overridden shall be displayed on the graphic screen by an icon adjacent to the overridden point to provide a quick visual indication of any points on the screen that are overridden.
6. The viewing and modification of weekly schedules shall be performed in a graphically intuitive manner that is consistent with the non-Web Enabled application. This shall be performed without the addition of any “client side” software, plug-Ins, or additional applications.
7. The viewing and modification of annual holiday schedules shall be performed in a graphically intuitive manner that is consistent with the non-Web Enabled application. This shall be performed without the addition of any “client side” software, plug-Ins, or additional applications.
8. “Right clicking” on the point and modifying the value shall perform the editing of point values.
9. Points can be placed in “manual” or “automatic” mode from the Web Browser, providing password restrictions for the user allow such functionality.”

2.21 ELECTRICAL WIRING

A. All wire, wiring, and conduit required for the operation of the control system shall be the responsibility of this section of the specifications and shall be installed as described and in full accordance with the requirements of Division 26 of these Specifications.

B. The control manufacturer shall be responsible for supplying complete and approved wiring diagrams and installation supervision of the wiring of the control system and shall perform all necessary set-up and calibration labor.

C. Starters, furnished in other sections of these specifications, shall be installed under Division 26, but all wiring from auxiliary contacts or relays shall be under this section of the specifications.

D. All wiring, including Class 2 signal wiring, shall be installed as a Class 1 electrical system as defined by the National Electrical Code (NEC).

E. All control conduits with #8 conductor or smaller (cross-sectional area) shall have one pull wire each run in conduits carrying 5 or more conductors. Conduits with 9 or more conductors shall have two pull wires installed. Terminate pull wires at control panels in an acceptable manner and tag wires as “future”.

F. The electrician shall be licensed by the City and local authorities having jurisdiction over the area in which the work is to be performed.

G. All class 1 control wiring conduit shall be run with not more than 30% fill based on inside conduit diameters and cross-sectional area. This provision is for future modifications or additions to the control system.

H. All conduit carrying shielded twisted pair cabling, communication, or signal, Class 2 wiring, shall be sized for a maximum of 40% fill based on inside conduit diameter and cross-sectional area. This provision is for future modifications or additions to the control system.

I. All wiring shall be run in conduit unless specifically indicated otherwise herein. All Class 1 power wiring shall be run in conduit. All Class 2 signal wiring, low voltage control type, shall be run in conduit. No exposed wiring of any kind will be allowed. However, Class 2 signal wiring may be installed without conduit above accessible lay-in ceilings only if run-in plenum rated cable, supported independently from structure, and run parallel and perpendicular to the structure.

J. All conduit shall be 3/4 inch size minimum, except raceways terminating at control devices manufactured with 1/2" knock-outs, i.e., conduit from junction box to smoke or fire detectors (local single device wiring only).

K. Electrical Systems Installer on project may perform temperature control conduit and wiring installation on project only that this portion of work shall be bid directly to the Temperature Control Systems Installer, and all work in relation to temperature control wiring shall be done subordinate to this Section of the Specifications. Wiring terminations shall be under this Section of the specifications.

L. Under this Section of Specifications, furnish and install, at an early stage of construction (when walls are being constructed) galvanized steel back boxes for all wall mount space sensors, suitably secured with 3/4" EMT routed to four inches (4") above an accessible ceiling. Install with pull wire for installation of sensors and related wiring at a later stage of construction.

M. Work Not Included Under this Section of Specifications: The Electrical Systems Installer shall provide:

1. Branch circuit and motor feeder circuit conductors, raceway, connections, and overcurrent protection for each motor or item of equipment furnished by the Owner or other Contractors.
2. Installation of motor controllers furnished by the Owner or other Contractors, along with branch circuit and motor feeder circuit conductors, raceway, and connections in accordance with the manufacturer's approved wiring diagrams.
3. Disconnect switches, where indicated on the drawings or required by codes, except as provided as an integral part of manufactured equipment.
4. Power supply conductors, raceway, connections, and over-current protection for input power to HVAC Temperature Controls, HVAC Automation, HVAC Energy Management Systems and combination fire-smoke and smoke dampers in accordance with approved rough-in and connection diagrams furnished by the system suppliers only when shown on Division 26 Drawings.
5. The above represents an outline of the work for the purpose of describing one division of the work which is acceptable to insure that all work is contained within the General Contract. The Contractor is fully responsible for the installation of complete, operating systems in accordance with the functional intent of the specifications.
6. Nothing herein shall be construed to confine the Contractor from assigning the work to any single member or group of systems installers deemed best suited for executing the work to effect completion of the contract. Refer to specific bidding instructions of the General Contract for the actual division of the work.

N. Work Included Under other Sections of Division 23 of the Specifications: The Mechanical Systems Installer shall provide:

1. Motors and equipment, erected in place and ready for final connection of power supply wiring, along with manufacturer's approved wiring diagrams.
2. Motor controllers, in suitable enclosures and of the type and size in accordance with the manufacturer's recommendations and NEMA requirements, along with properly sized overload elements or devices which are normally provided as part of manufactured equipment.
3. Disconnecting switches or devices which are normally provided as a part of manufactured equipment.
4. Rough-in and connection diagrams for input power supply and connections for the HVAC Temperature Control, HVAC Automation, and HVAC Energy Management Systems.
5. The above represents an outline of the work for the purpose of describing one division of the work which is acceptable to insure that all work is contained within the General Contract. The Contractor

is fully responsible for the installation of complete, operating systems in accordance with the functional intent of the specifications.

O. Contractor, under this Section of the Specifications, shall insure the furnishing and installation of:

1. All new branch circuit wiring, conduits, protective devices and accessories for power supply wiring to serve new control panels, control transformers, electric control dampers and valve actuators, and any other control system power requirements where not shown to be performed by others. Field verify spare electrical circuits available where applicable. Do not tap into existing branch circuits without approval by the Owners Representative. Run all new circuits back to electrical feeder panels.
2. Conductors and raceways for the HVAC temperature control, HVAC automation, and HVAC Energy Management System in accordance with approved rough-in and connection diagrams furnished by the system suppliers.
3. Termination of all conductors, raceways, devices, and connections for low voltage systems for the HVAC Temperature Control, HVAC Automation, and HVAC Energy Management Systems in accordance with the provisions of Division 26, and approved systems shop drawings to provide complete operating systems in accordance with the functional requirements of the specifications.

P. Wire all safety devices in series to include freezestats, smoke detectors, and static pressure high limit controls; any single device when tripped, shall de-energize air handling equipment.

Q. Wiring Requirements shall also include the following:

1. The conduit/wiring system required for the Automatic Temperature Control (ATC)/Energy Management System shall be a complete, separate, independent system. Conduit sharing with other unrelated electrical systems is not permitted.
2. All wiring shall be labeled at both ends and at any spliced joint in between. Wire and tubing shall be tagged using 3M, Scotch Code Write On Wire Marker Tape Identification
3. System; product number SWD-R-11954 with 3/4" x 5/16" write-on area or SLW 12177 with 1" x 3/4" write-on area and with 3M Scotch Code SMP Marking Pen. In addition to tagging at field device end and at spliced joints, a tag shall be placed 6" after entering each DDC panel. Identification and tag information shall be included in engineering/wiring submittal which must be submitted for Owner approval prior to beginning work. Tag information shall coincide with equipment/point information as written in the specification Input/Output summary.
4. Digital Input (D.I.) wiring (Class 2) may be run in a common conduit with Digital Output (D.O.) Wiring (Class 1) where local codes permit.
5. Analog Input (A.I.), Analog Output (A.O.), Digital Input (D.I.), and Network Communications Trunk (N.C.T.) wiring may be run in a common conduit.
6. Digital Output (D.O.) wiring run in a common conduit with Analog Input (A.I.), Analog Output (A.O.), or Network Communication Trunk (N.C.T.) is not permitted under any circumstances.
7. AC line power to DDC panel shall be #12 THHN.
8. Digital Output (D.O.) wiring shall be #14 THHN.
9. Digital Input (D.I.), Analog Input 4-20 mA (A.I.) and Analog Output (A.O.) wiring shall be #18 TSP (twisted shielded stranded pair with drain wire).
10. Analog Input or voltage types (A.I.) wiring shall be #18 TSP (twisted shielded stranded pair with drain wire).

2.22 GENERAL

A. System shall be installed complete with DDC panels, remote panels, thermostats, sensors, control valves, control dampers, all actuators, switches, relays, alarms, etc., and control conduit in accordance with the extent of the sequences of operation. Provide all auxiliary equipment required. All controls shall be installed under this section of work, with the exception of valve bodies, piping thermowells, automatic dampers and taps for flow switches and pressure sensing devices which shall be furnished under Sections 23 21 13 and 23 30 00.

B. Control Systems manufacturer shall submit a complete and final check list verifying final calibration and set points for each system prior to final construction review.

C. Complete control drawings shall be submitted for approval before field installation is started. The submittals shall give a complete description of all control devices and show schematic piping and wiring, as well as a written sequence for each operation.

D. All control dampers shall be furnished by Control manufacturer and shall be set in place, under other sections of the specifications, and be adjusted for proper operation, including the installation of necessary linkages with actuators under this section of specifications. Contractor shall also furnish, under other sections of the specifications, install any necessary blank-off plates required to fill duct when damper size is smaller than the duct. All outside and relief air damper frames and blank-off plates shall be caulked air tight with non-hardening silicone caulking to the ductwork or frame opening.

E. Work under this section shall regulate and adjust the control system, including all controllers, thermostats, relays, control valves, motors, and other equipment provided under this contract. They shall be placed in complete operating condition subject to the approval of the TAB firm. Contractor shall cooperate fully with the balancing agency in the testing, check-out and adjustment of the various systems. Contractor, under other sections of these specifications, shall install all wells, valves, and automatic dampers.

F. Control system herein specified shall be free from defects in workmanship and material under normal use and service. If, within twelve (12) months from the date of "Substantial Completion", any of the equipment herein described is proven to be defective in workmanship or material (except electrical wiring done by others), it shall be adjusted, repaired, or replaced free of charge.

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATION - CHILLERS CH-1 and CH-2

A. The liquid chiller system shall be energized by the Energy Management System and software interlocked to run when any air handling unit served with chilled water is energized, requires cooling and the economizer cycle cannot meet load demand. Provide manual disconnect for each control circuit.

B. Provide a primary chilled water return temperature sensor set at 54 degrees F., adjustable, to open the primary chiller isolation valve, energize the lead primary chilled water pump and the respective chiller served after proof of flow is verified. Open the second (lag) chiller isolation valve and start the second (lag) primary pump and chiller in the same manner after a rise of common secondary pump discharge temperature of 2 Deg.F., or more, adjustable, above chiller setpoint, initially set at 42 Deg.F., for 30 minutes or longer, adjustable.

C. Turn off second lag chiller and respective primary pump, with auxiliaries, after a 30 minute time delay (each chiller to run a minimum 30 minutes), adjustable, if the flow rate in the bypass, supply to return, exceeds 110%, adjustable, flow rate of one chiller, the lesser value of the operating chillers, the secondary supply temperature is less than 2 degrees above chiller setpoint, i.e., less than 44 Deg.F., adjustable, and the temperature difference of the secondary supply and primary return is less than 5 Deg.F., adjustable.

D. Alternate starting of chillers and respective primary pumps and auxiliaries to provide even distribution of operating hours for the two chiller systems through software. Upon a call for any chiller to start and failure of chillers to start, an alarm shall be sent and chillers shall stage and sequence without chiller in alarm until alarm is acknowledged and chiller is re-activated.

E. Initially, one primary pump and chiller and auxiliaries will start and as load increases beyond the capacity of that chiller then the second chiller system will be energized. As load decreases, the reverse shall occur.

F. Chiller capacity shall be controlled by individual chilled water discharge thermostats for each chiller, set at 42 degrees F. (adjustable).

G. Chiller safety and operating controls shall be master over auxiliary controls.

H. Chillers shall be turned on only after respective primary pumps have started and proof of flow is made in the evaporator. Flow switches are differential pressure type furnished under other Sections of these Specifications. Chillers shall be turned off 15 minutes, adjustable, prior to the respective primary pumps being de-energized unless the chiller manufacturer allows this time to be decreased.

I. Chillers shall be started after a one-minute time delay (adjustable) after the chilled water pumps are started and proof of flow is verified. Lock out the chillers and chilled water pumps below 40 deg. F. outside air temperature, adjustable.

J. Provide differential pressure flow switches, under this Section of the Specifications, if not specified to be furnished with the chillers, in the chilled water lines to prevent chiller operation unless flow is proven. Flow switches shall be located between isolation valves and chillers. Utilize McDonnell & Miller differential pressure type switches.

K. Provide other interlocking relays to de-energize pumps as required by safety controls of chiller manufacturer, under this section of the specifications.

L. Hand-Off-Auto (H.O.A.) Switches, for control of primary chilled water pumps, shall be provided at the motor controllers under other Sections of these Specifications. Control and interlock wiring through motor controllers shall be performed under this Section of the Specifications. Wiring shall be such that pumps shall be capable of turning "On" in the hand position without energizing chillers or other interlocks that should operate only when turned on in the automatic position. However, all safety devices shall be wired to operate in both the "Hand" and "Auto" positions.

M. Any time a primary pump is energized the designated chilled water distribution pump shall be started and be controlled as indicated elsewhere herein.

3.2 CHILLED WATER DISTRIBUTION SYSTEM - PUMPS CHP-1 and CHP-2

A. Chilled Water Distribution Pump CHP-1 or CHP-2 shall distribute chilled water to the building for cooling effect. These pumps shall be alternated by the EMS every 48 hours, adjustable, for even wear of equipment and accessories.

B. Provide manual disconnect for the control circuit. Additionally provide for Hand-Off-Automatic (H.O.A.) switch control through the individual motor controller, controllers furnished under other Sections of these Specifications, for each pump. Only the pump served shall operate through the "Hand" position, to include full functioning of all safety devices. In the "Auto" mode, both safety and interlock wiring shall function as specified. This wiring shall be performed under this Section of the Specifications.

C. Chilled Water Distribution Pump CHP-1 and CHP-2 shall be connected to separate variable frequency drives such that one or the other may be operated from the respective variable frequency drive, or manual bypass starter, but both shall not be capable of being operated from the same motor controller simultaneously. When the EMS switches from one pump to the other, it shall also switch the motor controllers.

D. Chilled Water Distribution Pumps CHP-1 or CHP-2 shall operate anytime an air handling unit, or group of units, is operating and requiring cooling, during building cool-down, night set-up and during the freeze protection mode. One distribution pump will be energized instantaneously when any primary chilled water pump is energized. Each pump shall be started at minimum pump manufacturers recommended speed and ramp up to maintain the system design differential pressure set point.

E. Provide two (2) differential pressure sensors with transmitters at the chilled water coil of the furthest air handler and highest pressure drop air handler in the building AHU-A1 and B1 . The design differential of greatest demand shall be maintained through the variable frequency drive modulating the speed of the active distribution pump or pumps. The design differential shall be the combined pressure drop of the control valve and the cooling coil, and shall be field determined by the Testing, Balancing and Adjusting

(TAB) Agency. Utilize a 30 PSIG range differential sensor. Provide test tee with gauge cock for TAB firm testing.

F. During chilled water distribution system freeze protection, all inactive air handling unit and fan coil unit chilled water valves shall be open to the coil and one (1) chilled water distribution pump shall be activated and maintain the design differential water pressure set point. This sequence shall be activated by software any time the outside air temperature is below 35 Deg.F., the building is secured (generally unoccupied); air handling and fan coil units are generally all off, and not operating in a night set-back or morning warm-up mode.

G. Upon a call for the lead pumps to energize and failure of the lead pump to energize, the lag pump shall be energized and an alarm sent. The lag shall then be the lead pump. The system shall operate with one (1) pump until the pump in alarm is acknowledged and the pump is re-activated.

3.3 SEQUENCE OF OPERATION - BOILERS B-1 AND B-2

A. The heating water system shall be energized whenever the outside air temperature drops below 68 Deg.F., adjustable and the building is in “Winter” or “Heating” mode. When the system is called to be energized the designated distribution pump(s) will be started. Upon proof of adequate water flow through the boiler(s) and a minimum return water temperature of 50 Deg.F., or higher, adjustable, the boiler(s) shall be energized and staged on by the boiler monitoring system to provide optimum efficiency.

B. Boilers shall be staged on and capacity modulated by the boiler management system (BMS) to provide the heating water supply temperature set point as determined by the heating water supply temperature reset schedule indicated elsewhere herein. This shall occur such that the system efficiency is optimized.

C. Alternate the lead/lag of boilers and pumps so all boilers and pumps are cycled through evenly. Alternate which boiler is designated as lead through the (BMS) after each scheduled shut-down, or a minimum of once every 48 hours. If the lead boiler or pump fails, start the lag boiler or pump, as applicable, and send an alarm to the Central Computer. BMS shall be installed, connected to all boilers, and integrated with the Building EMS through a ModBus interface under this Section of the Specifications.

D. Provide an outdoor air temperature sensor, mounted outdoors and shielded from the direct rays of the sun and from any other source of radiant heat, to control the building heating water supply temperature reset schedule through the boiler management control system.

1. Supply water temperature sensor to be located in the common heating water supply downstream fo all distribution pumps.
2. Outside air reset schedule shall be adjustable and shall provide for 145 Deg.F. supply at 25 Deg.F. ambient and 75 Deg. F. supply at 65 Deg. F. ambient, all adjustable.
3. Provide a common boiler entering, return, water temperature sensor to override the reset temperature to maintain a minimum 60 Deg. F., adjustable, boiler water return temperature.

E. Boiler firing shall be controlled by boiler equipment furnished flame supervision and burner controls.

F. Hard-wire, an outside air thermostat or provide EMS command, field adjustable, to start water distribution pumps HWP-1 or HWP-2 when the outside air temperature drops to 35 Deg.F., or below, adjustable. This control shall be independent of other controls, or the Energy Management System, for unoccupied freeze protection under this Section of the Specifications.

G. Provide an audible alarm, hard-wired, in the Mechanical Room in the event of a distribution water pump failure (pump commanded “On” with status of “Off”), or boiler failure (through gas valve relay), with a silence button under this Section of the Specifications.

H. Each boiler is sized for 2/3 of the total diversified load on the system such that both boilers will need to be energized to meet full load conditions. The heating water distribution pumps are sized for full diversified flow in the system such that only one (1) distribution pump should be needed at a time and they are fully redundant.

I. Hard-wire, a Carbon Monoxide Sensor, field adjustable, to de-energize Boilers when a carbon monoxide level of 50 PPM, or greater, adjustable is sensed. This control shall be independent of other controls, or the Energy Management System, under this Section of the Specifications. The associated Carbon Monoxide Sensor shall also monitor and send an indication of carbon monoxide level to the EMS system.

3.4 HEATING WATER DISTRIBUTION SYSTEM - PUMPS HWP-1, AND HWP-2

A. A Heating Water Distribution Pump, HWP-1 or HWP-2 shall be activated when the building is occupied, any designated group of terminal units is energized and requires heating and the boilers are energized as indicated elsewhere herein, to include during night set-back, optimized start/warm-up and when in the unoccupied mode and the outside air temperature drops to below 35 Deg.F., adjustable (heating water system freeze protection).

B. Provide manual disconnect for the control circuit. Additionally provide for Hand-Off-Automatic (H.O.A.) switch control through the individual motor controller, controllers furnished under other Sections of these Specifications, for each pump. Only the pump served shall operate through the "Hand" position, to include full functioning of all safety devices. In the "Auto" mode, both safety and interlock wiring shall function as specified. This wiring shall be performed under this Section of the Specifications.

C. Heating Water Distribution Pump, HWP-1, or HWP-2 shall be connected to separate variable frequency drives such that one (1) or the other may be operated from their respective variable frequency drive or manual bypass starter, but both shall not be operated together or from the same motor controller simultaneously. Pumps shall be alternated by the EMS from one pump to the other, to equalize run time of each pump, a minimum of once every 48 hours, adjustable. The lead pump shall be started at minimum pump manufacturers recommended speed and ramp up to 100% speed to maintain the system design differential pressure set point.

D. Provide four (4) differential water pressure sensors with transmitters in the heating water system at the heating water coil of the fan powered terminal on level one and two at the end of the heating water loops. This shall be FPB-A1-105 in Unit A, Level 1; FPB-B1-130 in Unit B, Level 1; FPB-C1-104 in Unit C Level 1; and FPB-B2-204 in Unit B, Level 2. The design differential of greatest demand shall be maintained through the variable frequency drive modulating the speed of the active distribution pump. The design differential shall be the combined pressure drop of the control valve and the heating coil, and shall be field determined by the Testing, Adjusting and Balancing (TAB) Agency. Provide a test tee with gauge cock for TAB firm testing. Use a 30 PSIG Range Differential Sensor.

E. During heating water system freeze protection, all inactive terminal units heating water control valves shall open to their coils and one (1) distribution pump shall maintain the design differential. This sequence shall be activated anytime the building is secured (unoccupied) and the outside air temperature is below 35 Deg.F.

3.5 SEQUENCE OF OPERATION - VARIABLE VOLUME AIR HANDLING UNITS, WITH VENTILATION CYCLE: AHU-BG, A1, B1, B2 & C1

A. Each fan control circuit shall include all required safety controls, a Hand-Off-Auto (H.O.A.) Switch, timer (EMS) energized controls, a manual override switch, a night set-back/set-up sensor(s), and separate morning warm-up/cool-down sensor(s).

B. The safety controls, to be wired in series, shall consist of, but not be limited to the following:

1. A manual disconnect switch.
2. A building fire alarm relay.
3. A manual reset adjustable freezestat(s).
4. Return air smoke detector.
5. A manual reset supply fan discharge duct static pressure high limit switch.
6. UV Light Array.

C. With all safety controls closed and the H.O.A. Switch in the "Auto" position, the fan circuit shall be controlled by the EMS. This circuit shall also include control of the variable air volume terminal units. All safety devices shall be functional when the H.O.A. switch is in the "Hand" position.

D. A low limit thermostat in the mixed air stream, upstream of the water coils, shall stop the air handling unit when the temperature falls below setpoint, field adjustable, of 40 Deg.F. Freezestat shall have a minimum 20 feet long element and shall be sensitive to temperature changes along any 12 inch length. Element shall be installed in a serpentine fashion with element parallel to the horizontal. The element shall extend across the unit cross-section (coil width) a minimum of three times. If this cannot be achieved with one element, then multiple freezestats shall be used. All freezestats and other safety devices shall be wired in series.

E. Ionization smoke detector shall be provided in the return air ducts for each unit and shall stop the air handling unit whenever products of combustion are sensed.

F. Provide a manual reset high limit duct static pressure sensor, located in the supply air duct, to de-energize air handling unit upon a rise above setpoint, as recommended by the Test and Balance Agency, but not more than 1.0 inch W.G. above system operating duct static pressure requirement at supply fan discharge at 100% fan speed and full system air flow.

G. UV Light array shall be monitored and alarm when not functioning properly.

H. The outside air dampers shall be locked out, closed, during the morning warm-up or cool-down and night set-back or set-up modes of operation. Lock out chilled water flow to the cooling coil during morning warm-up and night set-back modes. Lock out heating water flow to the heating coil during the morning cool-down and night set-up modes.

I. Designate separate space temperature sensors, one (1) for morning warm-up and cool-down (located at an interior space), and one (1) for night set-back and set-up (located on a partition wall of a room on a North-Northwest, or exterior exposure, as recommended by the balancing agency for each AHU.

J. Supply fan capacity shall be controlled by a system static pressure sensing station installed in the supply air duct near the extremity of the system, as recommended by the balancing agency, set point to be field determined by the balancing agency. The system static pressure controller shall automatically reset the supply fan speed through a variable frequency drive, to match the capacity requirements of the system. The supply duct static pressure set point shall be field determined by the TAB firm and shall be adjustable. The following additional requirements shall be met:

1. The duct static pressure set point shall be set by the operator and shall be set initially at 1.25 inches W.G., to be revised to a set point at the conclusion of the TAB work.
2. The space static pressure set point shall be initially set at 0.03 inches W.G. (Positive pressure inside the building). Locate indoor sensor reference in the largest single space served by the air handling unit.
3. All set points shall be fully adjustable and shall be verified and set by the TAB firm at the completion of the test and check out period.
4. If the duct static pressure is outside the operator established low and high alarm limits, initially set at 0.5 and 1.75 inches W.G. then generate an alarm to the EMS.

K. Supply air duct discharge temperature shall be maintained at 54 Deg.F., Adjustable, by modulating a control valve on the chilled water coil. Refer to plans for two or three way valve designation. All valves are two-way type except those at the end of the system which shall be 3-way type only where designated. The cooling coil control valve shall go to full bypass on 3-way valves, or close for two-way valves, when the fan ceases operation. Provide reset capability of discharge air temperature, adjustable, to increase discharge air temperature from 54 Deg.F. to 64 Deg.F. upon a decrease in fan speed, or fan volume, from 50% to 30%, adjustable. Reset shall also occur when the unit is operating in the ventilation cycle. Should the return air (or space, where applicable) relative humidity rise to above 60% R.H., inversely reset the discharge air temperature downwards to prevent exceeding 60% R.H. in the building.

L. Provide interlocks for minimum outside air and ventilation cycle control as follows:

1. Minimum outside air control shall be maintained throughout the range of the AHU by an air flow monitoring station located in the minimum portion (a separate maximum outside air control damper required for maximum air quantity control) of the outside air duct system as follows:
    a. When the unit is operated in an occupied mode the outside air flow monitoring station shall control the air flow to match the “minimum-minimum” value as scheduled on the Drawings regardless of the supply air capacity.
    b. A return air carbon dioxide sensor (AHU-B1, B2 and C1 only) shall be used to regulate the introduction of outside air, to maintain a set point of 1100 PPM, adjustable, to above the minimum-minimum” value scheduled up to no more than the “minimum-maximum” value scheduled, as limited by the air flow monitoring system outside air control dampers.
    c. Lock-out carbon dioxide sensor control when the unit is operated in the economizer mode.
2. The minimum outside air control dampers shall be closed when the respective AHU served is not operating and during unoccupied modes of operation noted elsewhere herein.
3. When the air handling unit is operated in the economizer mode, or when the space becomes over pressurized, the relief air system shall be released to be controlled to maintain the building positive pressure set point indicated elsewhere herein.
4. Maximum outside air control for the ventilation cycle shall consist of the sequenced opening of the separate normally closed (N.C.) maximum O.A. dampers, and the closing of the normally open (N.O.) return air dampers to maintain a 54 Deg. F. mixed air temperature. Ventilation cycle shall be energized when the outside air temperature drops to 60 Deg. F., field adjustable. Normally closed (N.C.) relief air dampers shall be interlocked to operate in sequence only with the maximum O.A. dampers in operation, or when the space becomes over pressurized as noted elsewhere herein.
5. Provide a low limit mixed air plenum thermostat, separate from the system freezestat(s), serpentined capillary sensor, to override the ventilation cycle controls to prevent supply air less than 52 Deg. F. from entering the system. This shall include modulated closing of the outside air dampers to maintain the set point.
6. Provide for independent control and adjustment for each of the minimum and maximum outside air dampers and each of the return and relief air dampers to allow for maximum flexibility, adjustment and ability to control minimum outside air flow rates and building pressure.
7. Provide for an optimized economizer cycle such that the chilled water control valve remains closed during the normal operation of the economizer. Once the outside air dampers are at 100% open and the discharge air temperature set point cannot be maintained, then the chilled water valve shall modulate open as required to assist in maintaining this set point.
8. When the space pressure rises above a set point of 0.03 inches water gauge, adjustable, or when the maximum outside air dampers are modulated open, the relief air system shall be energized. This shall first consist of the opening of the relief air dampers. As the space pressure continues to rise, or with the maximum outside air dampers further modulating open, the relief air fan shall be started at low speed and increase in speed as needed to maintain space pressure set point. As the space pressure drops to below set point, the reverse sequence shall occur.

M. A manual override push-button, or dial time switch, located in the AHU control panel, shall restart the AHU system and normal operating controls for a period of two (2) hours (adjustable up to a maximum of 4 hours) when activated. This shall include interlock to energize the chilled and heating water system distribution pumps, if not already energized, as needed. Alternately this may be achieved via override buttons installed on all space temperature sensors served by each AHU. Verify requirement with Owner.

N. The normal “occupied” mode of operation shall consist of all interior and perimeter fan powered terminal boxes being energized electrically, and then after a time delay, adjustable from zero to 60 seconds, the AHU system shall be energized. AHU system fans shall start at slow speed and gradually increase to full system flow requirements, or adjust to system demand level. Terminal units shall be controlled as a system on one control circuit with its respective AHU. The designated night set-back temperature sensor, located on an interior partition at a perimeter space served by the AHU (one per AHU located as recommended by the balancing agency), shall energize all fan powered and single duct VAV boxes with re-heat served by the AHU with air valves in the normally open positions, limited to no more than 100% of design air flow through the terminal, as applicable. Each terminal shall then be in control to satisfy the normal heating mode set point for that terminal unit. The control valve on each terminal hot water coil

shall modulate to satisfy the temperature sensor set point for VAV boxes and only after the respective terminal fan is energized based on a demand for heat for fan powered terminal boxes. Night set-back sensor set point, adjustable, shall be 55 Deg.F. Upon a rise in space zone temperature to 60 Deg.F. The entire system shall be de-energized. The respective AHU shall remain off in this mode. Lock out chilled water system, minimum and maximum outside air dampers and relief air dampers and fan during night set-back mode.

O. An optimized start morning warm-up cycle shall be provided to warm the area served by each AHU to 70 Deg.F., or within 1 Deg.F. of the normal occupied heating set point. This shall be accomplished by EMS control. When energized, and the designated warm-up/cool-down temperature sensor, one per AHU, located in an interior space served by the AHU (location as recommended by balancing agency), calls for warm-up, terminals shall be energized and operate the same as for the night set-back mode except that the set point shall be as noted above. The respective AHU shall remain off in this mode when connected to fan powered terminal boxes only. Where the unit is primarily served by single duct VAV terminals the unit shall operate in all set back and start-up modes. Once set point is reached, the system shall switch over to the normal mode, after which time the warm-up cycle shall be locked out until the next regularly scheduled warm-up cycle, not more than once each day. When switching to the normal mode, the AHU shall be started as indicated for the normal occupied mode.

P. An optimized start morning cool-down cycle shall occur, which shall consist of early start-up of the Air Handling Unit System the same as the normal mode with terminals under thermostatic control. Cool-down set point shall be 74 Deg.F., or within 1Deg.F. of the normal mode cooling set point. Once set point is reached, the unit will revert to the normal occupied mode. Sequence to occur not more than once each day.

Q. A night set-up mode shall occur when any space temperature sensor served by the AHU rises above 84 Deg.F, adjustable, which shall consist of AHU and terminals being operated the same as for the normal mode. Set-up shall be de-energized on a drop below 80 Deg.F, adjustable

R. When O.A. temperature is sensed below 30 degrees F., adjustable, close the O.A. dampers and fully open the return air dampers.

S. For AHU-A1, when the unit operates in economizer mode and the return air damper is closed, a separate return air damper in the Mechanical Room A001 shall also close. When the unit is operating in economizer mode, the exhaust fan serving Electrical A002 shall be energized to act as a relief air fan for this space (EF-A1).

T. For AHU-A1 and C1, the light intensity output shall be monitored and trended for documentation purposes for all units with Radiometers to confirm proper operation of UV light arrays.

U. For AHU-B1, it shall be interlocked with the Kitchen Dishwasher exhaust (EF-B15) and general kitchen exhaust fans (EF-B16 and EF-B17) such that if any of these fans are energized and the unit is not already energized, it shall be energized and the outside air dampers opened to the minimum-minimum position.

3.6 SEQUENCE OF OPERATION - INTERMITTENT FAN POWERED VARIABLE VOLUME TERMINAL UNITS

A. The terminal units shall be provided with air valves to fail in the N.O. position, or last position of control, upon loss of control signal, and fans shall run intermittently, drawing air from the plenum when energized (parallel type boxes) during the heating cycle.

B. Individual space thermostat shall maintain zone temperatures by modulating primary cold air quantities and sequenced staging of fan and operation of two or three way type modulating heating water control valves. On a call for full cooling, the air valve shall be set for maximum design CFM scheduled or indicated. On a fall in space temperature, the air valve shall modulate toward the closed position. The minimum position shall be as scheduled, only where the minimum does not exceed 40% of the design CFM. With the air valve at the designated minimum, or closed, position, as applicable, and on a further

drop in space temperature, the terminal unit fan shall be energized. On a further drop in space temperature the heating water control valve shall modulate open to maintain space temperature.

C. Terminals shall be instantaneously energized when the AHU system is energized with the respective air handling unit. Reference sequence of control for AHU's for the normal, night set-back, night set-up, morning warm-up and morning cool-down cycle requirements.

D. Air valves shall remain in normally open position with terminal de-energized. When in the warm-up and night set-back modes the air valve shall be limited to 100% of design air flow.

E. Two temperature sensors shall be provided the following Terminal Unit.

UNIT	PRIMARY SENSOR SPACE	SECONDARY SENSOR SPACE
FPB-BG-101	Record Storage B100E	Corridor
FPB-A1-101	Conf. Rm. A104F	Kitchen A104F-1
FPB-B1-121	Workstations B106	Office B106B
FPB-B1-123	Office B104F	Office B104D
FPB-B1-130	Conf. Rm. A101D	Office B102D
FPB-B1-131	Conf. Rm. A101B	Office B102C
FPB-B1-101	Office B103E	Workstations B103
FPB-B1-107	Office B105C	Office B107A
FPB-C1-111	Workstations C103	Office C103L
FPB-C1-119	Conf. Rm. C102A	Conf. Rm. C102D
FPB-C1-121	Office C105	Office C105A
FPB-C1-124	Office C106E	Workstations 107
FPB-B2-202	Conf. Rm. B201A	Conf. Rm. B202A
FPB-B2-205	Workstations B204	Conf. Rm. B204A
FPB-B2-212	Conf. Rm. B205B	Conf. Rm. B203A

The primary sensor shall control heating and cooling set point, unless the space temperature in secondary space is greater/less than 2.5 Deg.F., difference from set point. When this occurs, the secondary sensor shall control the heating set point until such time as it is within 1 Deg.F. of space set point. Once this temperature is reached, the primary space temperature sensor shall return to being the control sensor for the unit.

F. Where multiple terminal units serve a common space sensor both terminals shall operate together to control space temperature such that both units shall be in cooling or heating at the same time and both units shall modulate the primary air damper concurrently. Refer to Drawings.

3.7 SEQUENCE OF OPERATION - SINGLE DUCT VARIABLE VOLUME TERMINAL UNITS (WITH HEAT)

A. The terminal units shall be provided with air valves to fail in the N.O. position, or last position of control, upon loss of control air pressure.

B. Individual space thermostat shall maintain zone temperatures by modulating primary cold air quantities and sequenced operation of two or three way type modulating heating water control valves. On a call for full cooling, the air valve shall be set for maximum design CFM scheduled or indicated. On a fall in space temperature, the air valve shall modulate toward the closed position. The minimum position shall be as scheduled, only where the minimum does not exceed 40% of the design CFM. With the air valve at the designated minimum, or closed, position, as applicable, and on a further drop in space temperature, the heating water control valve shall modulate open to maintain space temperature. During heating mode, the air valve shall modulate open to a minimum of 60% of the design CFM with the heating coil energized.

C. Terminals shall be instantaneously energized when the AHU system is energized with the respective air handling unit. Reference sequence of control for AHU's for the normal, night setback, set-up, warm-up and cool-down cycle requirements.

D. Air valves shall remain in normally open position in the warm-up and night set-back mode and shall be limited to 100% of design air flow

3.8 SEQUENCE OF OPERATION - SINGLE DUCT VARIABLE VOLUME TERMINAL UNITS (NO HEAT)

A. The terminal units shall be provided with air valves to fail in the N.O. position, or last position of control, upon loss of control air pressure.

B. Individual space thermostat shall maintain zone temperatures by modulating primary cold air quantities. On a call for full cooling, the air valve shall be set for maximum design CFM scheduled or indicated. On a fall in space temperature, the air valve shall modulate toward the closed position. The minimum position shall be as scheduled.

C. Terminals shall be instantaneously energized when the AHU system is energized with the respective air handling unit. Reference sequence of control for AHU's for the normal, night setback, set-up, warm-up and cool-down cycle requirements.

D. Air valves shall remain in normally open position in the warm-up and night set-back mode and shall be limited to 100% of design air flow.

3.9 SEQUENCE OF OPERATION - CONSTANT VOLUME AIR HANDLING UNITS WITH ECONOMIZER: AHU-A2

A. The fan control circuit shall include all safety controls, an H.O.A. Switch, and timer (EMS) energized controls. All units have supply and return air fans which shall modulate together and offset shall be as set by the Testing, Adjusting, and Balancing (TAB) firm.

B. Safety controls shall consist of but not be limited to the following:

1. A manual disconnect switch.
2. A building fire alarm relay.
3. A manual reset adjustable freezestat(s).
4. Return air smoke detector.
5. A manual reset supply fan discharge duct static pressure high limit switch.
6. UV Light Array.

C. With all safety controls closed and the H.O.A. Switch in the "auto" position, the fan circuit shall be controlled by the EMS. Start chilled or heating water system, if not already operating, whenever any air handling unit is started

D. Provide manual reset high limit duct static pressure sensors, located in the supply air discharge plenum and downstream of the return air fans, to de-energize air handling unit supply fans or return fans upon a rise above set point, as recommended by the TAB firm, but not more than 1.0 inch W.G. above system operating duct static pressure requirement at supply fan discharge at 100% fan speed and full system air flow.

E. A low limit thermostat in the mixed air stream, upstream of the water coil, shall stop the air handling unit when the temperature falls below setpoint, field adjustable, of 40 Deg.F. Freezestat shall have a minimum 20 feet long element and shall be sensitive to temperature changes along any 12 inch length. Element shall be installed in a serpentine fashion with element parallel to the horizontal. The element shall extend across the unit cross-section (coil width) a minimum of three times. If this cannot be achieved with one element, then multiple freezestats shall be used. All freezestats and other safety devices shall be wired in series.

F. Ionization smoke detector shall be provided in the return air duct and shall stop the air handling unit whenever products of combustion are sensed.

G. UV Light array shall be monitored and alarm when not functioning properly.

H. Each supply fan is of the constant volume type and will be served by a variable frequency drive to allow the unit to be switched from off to 50% speed or up to 100% speed based on load and dependent on whether the unit is in either the cooling or heating mode. Space temperature shall be controlled by a room temperature sensor which will first start the AHU initially at 50% speed after which a two or three-way, normally closed to the coil, chilled water coil control valve shall be sequenced with a normally open to the coil heating water coil two or three-way control valve, no simultaneous heating and cooling, to maintain set point. On a demand for cooling, the cooling control valve shall modulate, as required, to meet the cooling set point. With the AHU fan operating at 50% speed, the chilled water control valve at 100% open, adjustable, and upon a further increase in demand for cooling in the space the fan speed shall be increased to 100%. The cooling control valve shall continue to modulate as required to satisfy set point. When the load decreases such that the corresponding chilled water control valve closes to a 40% open, adjustable, or less position, then the fan speed shall be reduced back to 50% speed. Once the chilled water valve closes fully and there becomes a demand for heat, the fan shall go to full (100%) speed. The heating control valve shall modulate as required to satisfy set point, however, the discharge air temperature shall be limited to 90 Deg.F., adjustable, during the heating mode. A normally closed (N.C.) minimum outside air damper shall open when the fan is energized in the normal mode and close when de-energized.

I. Provide interlocks for minimum outside air and ventilation cycle control as follows:

1. Minimum outside air control shall be maintained throughout the range of the AHU by an air flow monitoring station located in the minimum portion (a separate maximum outside air control damper required for maximum air quantity control) of the outside air duct system as follows:
    a. When the unit is operated in an occupied mode the outside air flow monitoring station shall control the air flow to match the “minimum-minimum” value as scheduled on the Drawings regardless of the supply air capacity.
2. The minimum outside air control dampers shall be closed when the respective AHU served is not operating and during unoccupied modes of operation noted elsewhere herein.
3. When the air handling unit is operated in the economizer mode, or when the space becomes over pressurized, the relief air system shall be released to be controlled to maintain the building positive pressure set point indicated elsewhere herein.
4. Maximum outside air control for the ventilation cycle shall consist of the sequenced opening of the separate normally closed (N.C.) maximum O.A. dampers, and the closing of the normally open (N.O.) return air dampers to maintain a 54 Deg. F. mixed air temperature. Ventilation cycle shall be energized when the outside air temperature drops to 60 Deg. F., field adjustable. Normally closed (N.C.) relief air dampers shall be interlocked to operate in sequence only with the maximum O.A. dampers in operation, or when the space becomes over pressurized as noted elsewhere herein.
5. Provide a low limit mixed air plenum thermostat, separate from the system freezestat(s), serpentined capillary sensor, to override the ventilation cycle controls to prevent supply air less than 52 Deg. F. from entering the system. This shall include modulated closing of the outside air dampers to maintain the set point.
6. Provide for independent control and adjustment for each of the minimum and maximum outside air dampers and each of the return and relief air dampers to allow for maximum flexibility, adjustment and ability to control minimum outside air flow rates and building pressure.
7. Provide for an optimized economizer cycle such that the chilled water control valve remains closed during the normal operation of the economizer. Once the outside air dampers are at 100% open and the discharge air temperature set point cannot be maintained, then the chilled water valve shall modulate open as required to assist in maintaining this set point.
8. When the space pressure rises above a set point of 0.03 inches water gauge, adjustable, or when the maximum outside air dampers are modulated open, the relief air system shall be energized. This shall first consist of the opening of the relief air dampers. As the space pressure continues to rise, or with the maximum outside air dampers further modulating open, the relief air fan shall be

started at low speed and increase in speed as needed to maintain space pressure set point. As the space pressure drops to below set point, the reverse sequence shall occur.

J. When O.A. temperature is sensed below 30 degrees F., adjustable, close the O.A. dampers and fully open the return air dampers.

K. Provide normal (occupied), morning warm-up and cool-down (unoccupied), and night set-back and set-up (unoccupied) modes of operation similar to that specified elsewhere herein. Outside air dampers shall remain closed during all but the normal occupied mode of operation.

L. Whenever the outside air temperature is above 57 Deg.F., adjustable, the air handling unit is operating in the normal occupied mode, and the space relative humidity level rises to above 60% R.H., adjustable, the chilled water control valve shall modulate open to effect further dehumidification. The fan speed shall be modulated down to 50% speed. During this mode of operation, the space temperature sensor shall modulate the fan speed and the humidity sensor shall control the cooling coil valve position. If the space temperature drops 2 Deg F, adjustable, below the cooling setpoint, for 5 minutes, adjustable, the re-heat coil shall be energized and the space temperature sensor shall modulate the heating coil valve to maintain the heating space setpoint until the humidity drops below the setpoint for 15 minutes, adj. If the heating water system is not energized it shall be energized.

3.10 SEQUENCE OF OPERATION - EXHAUST AND MAKE-UP AIR FANS

A. Where fans are designated to be thermostatically controlled, on a rise in space temperature above 78 Deg.F., the respective fan controlled shall be energized. When a fan is energized, the respective make-up air dampers, where indicated on the Drawings, shall be opened. On a fall in temperature to 75 Deg.F., the fan shall stop, and interlocked dampers shall be closed. Where fans are to be interlocked with heaters serving the same space, coordinate the furnishing of combination heating-cooling thermostats (individual thermostats for the fan and heater not allowed) such that heating and cooling cannot occur simultaneously. For spaces served by single duct VAV terminals, the VAV terminal shall provide cooling to the space whenever the associated air handler is energized, typically during occupied mode. Whenever the associated air handler is <u>not</u> energized, the exhaust fan shall be energized to control space temperature, typically during unoccupied mode. During occupied mode the exhaust fan and associated make-up air dampers shall remain closed, unless noted otherwise to operate for specific rooms in economizer mode operation.

B. Install fan speed control switches at a convenient location on direct drive fans on the load side of the disconnect. Refer to equipment schedules on the Drawings for direct drive fan designation. Fan speed controllers are furnished with the fans as specified under other Sections of these Specifications.

C. Exhaust fans shall be interlocked, be provided with locally manually controlled motor rated toggle switches with pilot lights where manual switches are scheduled and where specified in other sections of these specifications.

D. EMS controlled fans shall run continuously during normal occupied mode and be de-energized during all other modes of operation.

E. Interlock grease hood exhaust air fans and RTU-OAU-B1with respective fire suppression system of hood served to shutdown fans during discharge of suppression agent as required by local Code. Generally the outside air unit shall be turned off and the exhaust fans continue to run. Provide fan interlocks to operate exhaust air fans when switched "on" and "off" at the respective hood served. Switches are furnished with the hoods as specified in other Sections of these Specifications. Additionally, provide for the interlock with the grease exhaust hood manufacturer furnished exhaust air thermostat which shall energize the hood exhaust air system upon a rise in temperature above its set point. The three (3) grease exhaust hoods shall be provided with a MeLink system which shall allow for variable air flow of the three (3) grease exhaust fans GF-B1, B2, and B3. The fan speed shall be controlled by this system with remote variable frequency drives. The MeLink system shall be provided with a BacNET interface to allow for

communication with the EMS system and RTU-OAU-B1 to allow for the outside air damper to modulate open and closed in relation to the grease exhaust fan speeds. Refer to 100% Outside Air Unit Sequence for additional information.

F. Emergency exhaust fans in Discovery laboratories shall be started by emergency push button switches located where shown on the Drawings. The respective fan served shall operate for a period of 20 minutes, adjustable, whenever switch is pushed. The fan shall continue to run until button has not been pushed for 20 minutes. Push Button shall be the momentary contact type and shall NOT require manual re-set. Where there is an Isemet Lab Control system, the push button can be integrated with the lab controller. When purge switch is energized, the associated fan powered box serving the zone shall be de-energized and the main supply damper shall be fully closed.

G. The underfloor, crawl space, shall be mechanically ventilated by roof mounted exhaust fans which shall be cycled on as described herein. The intake air shall be introduced through wall louvers with motorized outside air dampers. Anytime the outside air temperature is above 35 Deg. F., adjustable, the exhaust fans shall be energized and outside air dampers shall be opened for timed intervals every 24 hours. This system shall be energized for two (2) hours and be off for one (1) hour, both adjustable, repeatedly and continuously over a 24 hour period such that the system operates for a total of 16 hours and is off for a total of 8 hours. Anytime the outside air temperature is below 45 Deg. F., adjustable, the fans shall stop. Lock-out time schedule operation when the outside air temperature is below 40 Deg.F., adjustable. Additionally, provide a crawl space relative humidity sensor, one per crawl space (2), to be located in the crawl space immediately adjacent to the respective floor access hatch (refer to Drawings). Whenever the relative humidity in the crawl space rises above 60% R.H., adjustable, override the time schedule and operate the exhaust fan until the relative humidity drops below 55% R.H., adjustable. When fans are disabled the outside air dampers shall be closed.

H. Kitchen dishwasher machine exhaust fans shall be interlocked to immediately be energized when the dishwasher is started. Include the addition of a time delay relay in the control circuit such that the exhaust fan will continue to run for five (5) minutes, adjustable, after the dishwasher machine is de-energized (interlock through booster heater control panel).

I. Other exhaust fans shall be interlocked, be provided with locally manually controlled motor rated toggle switches with pilot lights where manual switches are scheduled and where specified in other sections of these specifications.

J. Ventilation fan (EF-B14) for cooler/freezer plenum are shall run continuously during the unoccupied mode and for 15 minutes, adjustable, per hour during the occupied mode.

3.11 SEQUENCE OF OPERATION – DUCTLESS SPLIT DIRECT EXPANSION (DX) AIR HANDLING UNITS (AHU'S):

A. Wall mounted air temperature sensors shall be provided and installed under this Section of Specifications for monitoring and alarm purposes only.

B. A unit manufacturer furnished thermostat, furnished under other Sections of these Specifications, shall be installed under this Section of Specifications. The cooling set point shall be 72 Deg.F., adjustable. On a rise in space temperature above set point, energize the cooling system. On a 1-2 Deg.F., adjustable, drop below cooling set point, the system shall be de-energized and the compressor and fan shall both cycle off.

3.12 ELECTRIC UNIT HEATERS

A. Electric unit heaters shall be controlled by manufacturer furnished thermostats set at 68 Deg.F. (adjustable). On a fall in temperature below 68 Deg.F., the unit heater fan shall be energized after which the stages of heat shall be energized in sequence as needed to satisfy the set point. On a 2 Deg.F.,

adjustable, rise above set point, the heater will be de-energized in a reverse fashion of that described above.

B. Mount thermostats, under this Section of Specifications, on wall where indicated on the Drawings. Provide interlocks to any other devices, exhaust fans and intake dampers as scheduled.

3.13 SEQUENCE OF OPERATION - FAN COIL UNITS (NO OUTSIDE AIR)

A. The fan control circuit shall include all safety controls, an H.O.A. Switch, timer (EMS) energized controls, and a manual disconnect switch.

B. Safety controls shall consist of but not be limited to the following:

1. Building fire alarm relay (only as required by local code).
2. Return Air Duct Smoke Detector (when over 2000 CFM in capacity).
3. Boiler Room Carbon Monoxide Sensor.

C. With all safety controls closed and the H.O.A. Switch in the "auto" position, the fan circuit shall be controlled by the EMS. Start the chilled water system, if not already operating, as indicated elsewhere herein.

D. The supply fan is of the constant volume type and space temperature shall be controlled by a room temperature sensor which will modulate a two or three-way, normally closed to the coil, chilled water coil control valve sequenced with a two or three-way, normally open to the coil, heating water coil control valve, no simultaneous heating and cooling to occur. Both valves shall close when the unit is de-energized. Cooling and heating set points shall both be adjustable, but be initially set at 75 Deg. F. for cooling and 70 Deg. F. for heating.

E. Provide for a normal, morning warm-up, morning cool-down, night set-up and night set-back modes of operation similar to that specified elsewhere herein.

F. No outside air system exists for these units as they serve normally unoccupied spaces or ventilation is provided by separate equipment.

3.14 SEQUENCE OF OPERATION – ROOFTOP UNITS (SINGLE ZONE TYPE WITH 100% OUTSIDE AIR CAPABILITY): RTU-OAU-B1

A. The direct digital control system shall monitor and control each rooftop A/C unit. An electronic room temperature sensor shall, through a local terminal unit DDC Controller, one per unit, control its DX Cooling (modulating, hot gas reheat coils (except cooling only units), modulating gas heaters, economizer and outside and return air dampers, as applicable, to provide the following sequences:

1. The DDC controller shall be of the automatic change-over type to provide for a heating and a cooling set point to be software interlocked to prevent the cooling set point from being set below the heating set point and vice-versa. Provide for a minimum 2 Deg.F. dead band between set points, adjustable up to 5 Deg.F.
2. Include optimized start and stop features for unit control where the space temperature is compared to the ambient outdoor air temperature to calculate the minimum run time necessary to attain the normal mode set point by the occupied time scheduled.
3. Any time the rooftop A/C unit is in operation in the “Occupied” mode, the minimum outdoor air damper shall open to its minimum position except during morning warm-up (optimized start), night set-back, morning cool-down (optimized start) and night set-up.
4. Upon a need for mechanical cooling, the DX cooling system shall be energized in such a manner as to maintain a stable space temperature set point of 74 Deg.F (adj.). On a rise above set point the 1st stage of cooling, first compressor, shall be energized. For multi-stage units with modulating compressors, the additional compressor or stage will only be energized upon a further rise above set point and when the previous compressor or stage has been on longer than 5 minutes, adjustable. On a decrease in demand for cooling the compressors or stages shall be cycled off in reverse order to being energized. On a further decrease in space temperature, the first stage compressor shall be cycled off. Each stage of cooling shall have a minimum off time of

approximately 5 minutes (Variable as determined through PID loop control). The compressors are modulating type and shall modulate to control space temperature when energized in a stable fashion. When there are no kitchen grease exhaust fans (EF-GF-B1, B2, or B3) energized in the kitchen, the supply fan shall be allowed to modulate to control space temperature as well by reducing toe 50% speed when only one compressor is energized. When kitchen exhaust fans are energized, the unit shall supply constant airflow.

5. The space relative humidity (R.H.) sensor shall, through its DDC controller output signal, cause the unit to go into the dehumidifcation mode only when there is not a sensible cooling demand; and, upon a rise in space R.H. above set point, 60% R.H., adjustable. All units shall have a hot gas reheat coil, energized via a hot gas solenoid valve, which shall be used to reheat the supply air to a nearly neutral temperature only when in the dehumidification mode. Provide R.H. sensors for all units. Should the space temperature drop to below the heating set point, the dehumidification mode shall be de-energized and the gas heat shall be allowed to cycle on as needed to satisfy the heating set point once the compressor is cycled off. When there are no kitchen grease exhaust fans (EF-GF-B1, B2, or B3) energized in the kitchen, the supply fan shall be allowed to modulate to control space humidity by having the space temperature sensor control the fan speed and humidity sensor control the discharge air temperature of the cooling coil. When kitchen exhaust fans are energized, the unit shall supply constant airflow.
6. The heating temperature set point shall be 70 Deg. F., adjustable. On a drop in space temperature below heating set point, the furnace section shall be energized, in stages, as required, to maintain set point. The cooling system and hot gas reheat shall be de-energized while heating with natural gas. A supply air high limit control feature shall be provided to prevent the supply air temperature from raising above 90 Deg.F. by overriding and de-energizing the heat as required. The heat, when a demand for heat remains, shall shut-off for a minimum of three (3) minutes, adjustable, and be energized when the supply air temperature drops (fan runs continuously) below 80 Deg.F., adjustable. For modulating heating units, the furnace heating sections will stage on as required to meet demand in a stable fashion.
7. Since the unit is designed for up to 100% outside air and provides make-up air when the kitchen is operational and has minimal space cooling load when the kitchen is not in use, it is not equipped with a specific economizer cycle or sequence as it will always be using outside air to cool the space with an integrated economizer operation whenever there is a need for make-up air to the kitchen. The kitchen exhaust fans shall act as relief and exhaust fans. The cooling system shall stage up and down or off completely below 60 Deg F, adj. outside air temperature, as needed, to allow for economizer or free cooling operation when the space temperature and humidity setpoints are met. The mechanical cooling shall be energized if the space temperature setpoint rises or the humidity setpoint rises above the desired setpoint.
8. An evaporator motor current sensing relay will be interlocked through the DDC system in such a manner that anytime the unit fan is de-energized the gas fired heat and cooling compressors will also be de-energized unless operated for a heat purge sequence upon furnace shutdown after which time the furnace will shut down.
9. Space temperature sensors will also be used to operate the units in the unoccupied modes of operation.
10. During the optimized start morning “warm-up” mode (winter), the air unit fan motor will be cycled on and the unit furnace will be energized, as required, to bring space temperature to the normal heating set point. During this mode the outdoor air damper will be closed. When the space reaches warm-up set point, one (1) Deg.F. below the heating set point, the unit will then be allowed to operate in the “occupied” mode at which time the outdoor air damper will be allowed to open to minimum position, or be controlled by a carbon dioxide sensor as indicated elsewhere herein, and the system will be controlled as described above. Warm-up shall occur not more than once each day. The discharge air temperature high limit control sequence shall remain in control during the morning warm-up mode.
11. During the optimized start morning cool-down (summer) mode, the air unit fan motor will be cycled on and the unit cooling system will operate at the capacity as required to bring the space temperature to the normal cooling set point. During this mode, the outdoor air damper will be closed. When the space reaches cool-down set point, one (1) Deg.F. higher than the cooling set point, the unit will operate in the occupied mode at which time the outdoor air damper will be allowed to open to its minimum position, or be controlled by a carbon dioxide sensor, as indicated elsewhere herein, and the space temperature sensor will control as described above. Cool-down shall occur not more than once each day.

12. During the night set-forward and night set-back modes the equipment will be cycled as required to maintain those set points; on at 85 Deg.F. and off at 80 Deg. F., adjustable, for set-forward and on at 55 Deg.F. and off at 60 Deg.F., adjustable, for night set-back. The outdoor air dampers shall be closed in both of these modes. The discharge air temperature high limit control sequence shall remain in control during the night set-back mode.

B. The rooftop A/C units shall be furnished with factory furnished BacNET card which shall be interfaced in such a manner to control the outside air damper modulation in the following manner:

1. Unit shall be interlocked with grease exhaust fans (EF-GF-B1, B2, and B3). Unit shall be interlocked with EF-GF-B1, B2 and B3 through a BacNET communication through the kitchen hood MeLink system controller.
2. The rooftop A/C units shall be furnished with factory assembled modulating economizers with digital controller which shall be interfaced in such a manner as to:
    a. Allow the mechanical cooling system to be locked out and economizers to be enabled and disabled as hereinafter described. However, should the economizer be unable to maintain the cooling set point, the mechanical cooling system shall be energized as needed.
    b. Digital controller shall be interfaced in such a manner that when the A/C unit is in the economizer mode of operation it shall be controlled so it opens the outdoor air, above minimum setting, where applicable, only on a cooling demand by the space temperature sensor.
    c. Instrumentation and Control system provider shall furnish and install all necessary signal conditioners, relays, etc. to perform the exhaust fan and outside air damper interface as described herein. Coordinate these requirements with each specified equipment manufacturer.
    d. Provide for a discharge air temperature control, which shall prevent the discharge air temperature from dropping below 53 Deg. F., adjustable, when the unit is operated in the economizer, or free cooling mode.
3. If any of the grease exhaust fans are energized and Kitchen unit is not currently energized, it shall be energized and outside air dampers shall modulate to the position needed.
4. Kitchen Unit outside air dampers shall modulate with the signal from the MeLink system in the following manner:
    a. GF-B1 shall modulate the outside air damper in a 70% range (2,670 CFM) increment from 10% to 100% of that range.
    b. GF-B2 shall modulate the outside air damper in a 18% range (750 CFM) increment from 10% to 100% of that range.
    c. GF-B3 shall modulate the outside air damper in a 12% range (480 CFM) increment from 10% to 100% of that range.
    d. The total outside air flow of the unit is 3,900 CFM.
    e. The outside air dampers shall modulate as noted above based on the unit that is energized such that the airflow modulating range shall be additive through the BacNET controller on the RTU and the MeLink system and the dampers shall track the associated exhaust fan speed setting.
5. When all fans are energized and operating at full speed, the unit outside air dampers shall modulate to the maximum position.
6. When the Kitchen Grease Exhaust fans are fully de-energized, the Kitchen unit shall modulate the outside air damper closed.

C. Should the space temperature drop to 1 Deg.F., adjustable, below heating set point while the RTU is operating in the dehumidification mode, the unit shall go into alarm and revert to fan and compressor or furnace cycling (on-off) to meet space temperature (sensible load only) requirements until reset.

D. Unit Ionization Device:

1. Each unit provided with an ionization device (see mechanical schedules for listing) shall be enabled/disabled via interlocking with the supply fan control. After a 1-minute delay on a call for supply fan operation, the ionization devices shall be enabled. The EMS shall monitor the device for faults via dry contacts provided on the device. An alarm shall be generated if a fault is observed.

3.15 DOMESTIC HOT WATER RECIRCULATING PUMPS

A. Each circulating pump shall be controlled based on an independent time schedule as determined by the Owner.

B. Initial time schedule shall be to energize each pump control circuit beginning at 7:00 A.M. and to de-energize them at 5:00 P.M., all adjustable.

C. Once the pump control circuit is energized the pumps shall be energized in response to the individual aquastat, furnished and installed by the plumbing system installer, so that each pump maintains the desired loop temperature is attained. When the temperature drops to 10 Deg.F. below set point, the respective pump shall be energized.

3.16 SEQUENCE OF OPERATION - NIGHT SET-BACK AND SET-UP MODES

A. Night set-back and set-up modes shall be provided to keep equipment from operating except as needed to heat or cool the space to protect the building systems from freezing and potential water damage in cold weather or from excessive heat or humidity build-up in warm weather.

B. Designate one of the space temperature sensors shown on the plans, preferably located on an interior partition within 8 feet of a Northern exposure, selection as recommended by the balancing agency, to be used for night set-back control. Sensor, adjustable, shall be set for 55 Deg.F. Provide one per AHU for VAV units. For single zone systems, utilize the space temperature sensor shown. Use this same sensor for night set-up control which shall have a set point of 84 Deg.F., adjustable.

C. Below set-back setpoint, respective air handlers shall receive a control signal, fans shall be energized, and related heating equipment shall be started if not already energized, until all units are no longer in the night set-back mode, temperature rises above 60 Deg.F.

D. Above the night set-up set point, respective air handlers shall receive a control signal, fans shall be energized and related cooling equipment shall be started if not already operating, until the units are no longer in the night set-up mode, temperature drops below 80 Deg.F.

E. During the night set-back mode, lockout cooling system, ventilation cycles, morning warm-up and cool-down modes, night set-up mode, close all outside and relief air dampers, as applicable, and de-energize all EMS controlled toilet exhaust fans located in the areas served by the units being controlled.

F. During the night set-up mode, lockout the same systems, except allow the cooling system to be energized and lock-out the heating system.

3.17 SEQUENCE OF OPERATION - MORNING COOL-DOWN MODE

A. A morning cool-down mode shall be provided to cool the building, or area served by a system, to within 1 Deg.F. of the normal occupied cooling set point, adjustable, through the building Energy Management System optimized start feature.

B. Cool-down shall function the same as night set-up, except the set point shall be as noted above.

C. Lockout the cool-down mode after the cycle is completed until the following scheduled cycle, generally not to occur more than once per day.

D. During the cool-down mode, lockout the heating system, night set-back, morning warm-up, night set-up, close all outside and relief air dampers, as applicable, and de-energize all EMS controlled toilet exhaust fans in the areas served by the units being controlled.

3.18 SEQUENCE OF OPERATION - MORNING WARM-UP MODE

A. A warm-up mode shall be provided to warm the building, or area served by a system, to within 1 Deg.F. of the normal occupied heating setpoint, adjustable, through the building Energy Management System optimized start feature.

B. Warm-up shall function the same as night setback, except the setpoint shall be as noted above.

C. Lockout the warm-up mode after the cycle is completed until the following scheduled cycle, generally not to occur more than once per day.

D. Lockout the cooling system, ventilation cycles, night set-back, morning cool-down, night set-up, close all outside and relief air dampers, as applicable, and de-energize all EMS controlled toilet exhaust fans located in the areas served by the units being controlled.

3.19 ELECTRICAL INTERLOCKS

A. Certain electrical interlocks shall be as listed herein and in other sections of these specifications.

B. All electrical interlocks shall be made by means of auxiliary contacts on motor starters or shall be accomplished with separate relays unless indicated otherwise. No motor power lead shall be utilized in an interlock circuit, unless indicated otherwise. Each separate control power lead serving a starter shall be provided with a disconnecting switch suitably identified and housed, which may be a toggle switch or other suitable disconnecting device, of proper capacity and number of poles.

3.20 TEST, ADJUST, AND BALANCE SUPPLEMENTARY PROVISIONS

A. Furnish and install capabilities at each control device a test tee for testing of the control system on water distribution systems, to include input and output of all related control devices.

B. Furnish and install Pete's Plug or test tees with gauge cocks at water piping system temperature sensors/wells for verification, testing and calibration of each device without causing disassembly or removal of component systems.

C. Identify all required thermowells and supplementary test wells or plugs. Verify acceptable locations with TAB Firm. Then mark locations to be installed under Section 23 21 13.

D. Under this section of the specifications, provide a temperature test port adjacent to all EMS sensor locations. Additionally, furnish any other permanent test tees or wells for sensor calibration and for verification of all system monitoring data.

E. Under this section of the specifications, provide all thermowells for pipe mounted temperature sensors, pressure taps, test tees with cocks, sensors, wiring/cabling, etc., to be connected to the Energy Management System to include all points necessary for the sequence of operations specified hereinafter.

3.21 DDC CONTROL

A. Provide complete DDC Control for all equipment as indicated elsewhere herein.

B. Not more than one local unitary direct digital controller shall be utilized per AHU/piece of equipment.

C. Separate monitoring only control points not associated with specific pieces of equipment and which are global in nature are desired to be grouped together in a separate controller, or controllers, other than dedicated equipment controllers.

D. Each DDC controller used for Central Plant equipment control and those used as the main building network controller shall have their own real time clocks.

END OF SECTION

SECTION 23 21 12

PRE-INSULATED UNDERGROUND PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with the owner's - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other divisions for coordination of work with other portions of Work.

1.2 SYSTEM DESCRIPTION

A. Furnish and install all pre-insulated underground and aboveground piping of every kind required, specified, or shown on the Drawings suitable for the installation of the work specified in Division 23. The location, direction, and size of the various lines are indicated on the Drawings. Lines for pilot and controls and instrumentation are not shown but shall be installed as required and as specified.

B. Piping systems shall include all appurtenances shown on the drawings and as specified herein and other sections of these specifications.

C. Valves shall be installed to control the flow of water to each of the various systems, to segregate individual parts of fluid circulating or supply systems, and to permit draining of systems, or portions thereof, as directed on the Drawings and specified herein.

D. The work shall include the furnishing and installing of all supporting structures and members for pipes, anchors and thrust block restraints, as shown and as required.

E. Penetrations of walls and structural components shall be sealed off to limit water transmission through sleeves.

F. All pipes entering a structure or building from below grade shall be suitably anchored.

G. Provide for expansion loops in the piping systems as required for the piping sizes installed and temperature range of the water circulated through each system.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed by experienced mechanics certified and trained for the work performed.

1.4 SUBMITTALS

A. Product Data: Submit complete manufacturer's descriptive literature and installation instructions in accordance with Section 23 05 00 for all piping materials to be used for each system, valves and hydronic specialties as specified herein.

B. Shop Drawings: Submit in accordance with Sections 23 05 00. Submit 1/4" = 1'-0" Scale Piping Shop Drawings. Congested areas with sections shall be drawn at a scale of 3/8" = 1'-0". Include a complete layout of the system, showing all anchors, expansion provisions, and building or vault entrance details in submittals.

C. Fully coordinate piping shop drawings with other trades, as applicable. Failure to submit shop drawings in a timely manner, as required to keep pace with the construction and work of all other trades, will result in delays, and possible stoppage, of payment to the Contractor. Additionally, no work may proceed until such shop drawings are submitted, reviewed, and found to be acceptable by the Engineer.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

C. Take special precautions to protect valve internals from construction dirt and debris. If valves are stored on site, or installed in the underground piping system, cover the open ends of valve(s) or pipe openings until just prior to installation of other piping, or completion of the piping, but in no case shall valves, or pipes connected to valves, be left unprotected.

D. Openings in piping systems and valves shall be fully covered during the construction period to protect the interior accumulation of dirt and debris in these systems until immediately prior to connection to these components to similarly protected systems.

PART 2 - PRODUCTS

2.1 PRE-INSULATED BURIED AND ABOVE GROUND STEEL CHILLED AND HEATING WATER PIPING

A. Furnish a complete system of pre-insulated steel jacketed piping for underground and above ground piping as shown on the drawings. All pre-insulated pipe, fittings, insulating materials and technical support shall be provided by the pre-insulated piping systems manufacturers.

B. Carrier Pipe and Fittings:

1. Carrier pipe shall be black steel, ASTM A-53, Grade B, ERW (Type E) or seamless (Type S), schedule 40 for sizes 2" through 10" and standard weight for sizes 12" and larger.
2. When applicable, piping shall be furnished in 40-foot double-random lengths. Where necessary to meet job site conditions pipe lengths will vary and may be required to be much shorter in length.
3. All steel carrier pipe shall have ends cut square and beveled for butt-welding of field joints. Straight lengths of factory insulated pipe shall have 6" of exposed carrier pipe at each end for welding of field joints.
4. Fittings shall be SC (Standard Component) factory prefabricated and re-insulated fittings with polyurethane foam to the thickness specified herein and then jacketed as specified herein. Prefabricated elbow fittings shall be butt-welded to short steel carrier pipe “pups” or shall be bent in conformance with the standards set by ANSI B31.1, Code for Power Piping.

C. Jacketing for underground piping shall be extruded, black, High Density Polyethylene (HDPE), having a wall thickness not less than 125 mils for jacket sizes less than or equal to 12"and not less than 150 mils for jacket sizes larger than 12" and up to 24". No FRP, HDUP, or tape jacket allowed. The jacket throughout the entire system shall incorporate electric fusion, butt fusion, or extrusion welding at all fittings, joint closures, or other points of connection. This shall result in a jacket that is seamless throughout the entire system with the exception of anchors, which shall receive water shed rings that are sealed with a Raychem Dirax or Canusa GTS-65 wrap to prohibit the ingression of water.

D. Jacketing for pre-insulated above ground piping shall be 22 gauge galvanized steel, spiral wound, lock seam formed into steel tubes. Alternately use 0.032" thick aluminum jacketing.

E. Insulation shall be polyurethane foam, either spray applied or high pressure injected with one shot into the annular space between the carrier pipe and jacket. Insulation shall be rigid, 90-95% closed cell polyurethane with a 2.0 to 3.0 pounds per cubic foot density and coefficient of thermal conductivity (K-Factor) of 0.14 and shall conform to ASTM C-591. Maximum operating temperature shall not exceed 250

Deg. F. Minimum insulation thickness shall be a nominal two (2") thick for all underground piping as standard with the pipe manufacturer. Insulation for pre-insulated aboveground piping shall have an actual minimum thickness of two inches (2").

F. Moisture barrier end seals shall be factory applied, sealed to the jacket and carrier pipe. End seals shall be certified as having passed a 20 foot head pressure test. Ends seals shall be high temperature mastic, completely sealing the exposed end of the insulation. Field applied end seals shall be installed at any field cut to the piping before continuing with the installation.

G. Straight run field joints shall be insulated per the manufacturer's instructions, using polyurethane foam to the specified thickness, the same as the adjoining piping, poured in an electro-fusion welded split sleeve HDPE joint closure, Canusa Supercase, or Raychem Rayjoint. The joints shall be pressure tested at 5 psi for 5 minutes while simultaneously soap tested at the joint closure's seams for possible leaks. After passing the pressure test, the field joint is insulated and a closure patch is welded (same as joint closure instructions) over the foam injection hole. All joint closures and insulation shall occur at straight sections of pipe. Tape is not allowed.

H. Fittings shall be factory prefabricated and pre-insulated with polyurethane foam to the thickness specified and jacketed with a one piece seamless molded HDPE fitting cover, butt fusion welded, or extrusion welded and mitered HDPE jacket. No taping or hot air welding shall be allowed. All fitting jackets/covers shall be connected to the straight lengths of pipe by electro fusion, butt fusion, or extrusion welding. Carrier pipe fittings shall be butt-welded. Fittings include expansion loops, elbows, tees, reducers and anchors. Elbows, loops, offsets, or any other direction changes shall confirm to the standards set by ANSI B31.1, Code for Power Piping.

I. Expansion/contraction compensation shall be accomplished utilizing factory prefabricated and pre-insulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch (1") thickness), extending on either side, both inside and outside the radius of the fittings used, with all fittings having expansion in excess of 1/2".

J. Pre-insulated piping shall be furnished by Thermacor Process, Inc. or approved equals by Perma-Pipe or Thermal Pipe Systems. Underground piping shall be "Ferro-Therm PTS, Pressure Testable System" and above grade piping shall be "Thermacor Spiral-Therm".

2.2 AIR VENTS

A. Provide and install air vents where shown and at any high points or traps in water circulating lines where air might collect.

B. Each such air vent shall be installed with a valve at its inlet and a valved bypass, and it shall discharge through a check valve. The waste lines from the valved bypass and the discharge check valve shall be collected and piped to the nearest floor drain, or sanitary sewer, in each case.

C. All automatic air vents shall have cast or ductile iron bodies with corrosion resistant bolts and stainless steel, Buna-N or EPDM to match system requirements, and brass internal control components.

D. Provide manual air vent cocks for all water coils where not integral or supplied with coil by manufacturer.

E. Automatic air vents shall be rated for a maximum working pressure of 150 psig and 250 Deg. F.

F. Automatic air vents shall be as manufactured by:

1. Hoffman No. 792.
2. Armstrong No. AAE-150.
3. Bell & Gossett No. 107A.

2.3 BURIED SERVICE BUTTERFLY VALVE

A. Buried service butterfly valves shall be manufactured in accordance with the latest revision of AWWA C504 for Class 150B service and comply with the following details.

B. Valve bodies shall be constructed of ductile iron ASTM A-126 Class B and conform to AWWA C504 in terms of laying lengths and minimum body shell thickness. End connections shall be as specified on the plans.

C. Valve discs shall also be made from ductile iron ASTM A-126 Class B or ASTM A-48 Class 40 in sizes 24" and smaller. Disc shall be furnished with 316 stainless steel seating edge to mate with the rubber seat on the body.

D. Valve seat shall be EDPM rubber located on the valve body. In sizes 20" and smaller, valves shall have bonded seats that meet test procedures outlined in ASTM D-429 Method B.

E. Valve shafts shall be 18-8 Type 304 stainless steel conforming to ASTM A-276. Shaft seals shall be standard self-adjusting split V packing. Shaft seals shall be of a design allowing replacement without removing the valve shaft.

F. Valve bearings shall be sleeve type that are corrosive resistant and self-lubricating.

G. Valve actuators shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 ft. lbs. against the stop. The traveling nut shall engage alignment grooves in the housing. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.

H. The valve interior and exterior surfaces except for seating shall be coated with two coats of asphalt varnish in accordance with TT-C-494A and AWWA C504.

I. Buried service valves shall be furnished with a conventional valve box or five inch soil pipe to provide access to the AWWA nut by means of a tee wrench after backfilling.

J. Buried service valve shall be as manufactured by Pratt Groundhog with MDT actuator and Pratt Diviner Ground Level Position Indicator or equal.

PART 3 - EXECUTION

3.1 PIPING - GENERAL

A. Where special classes of piping are involved and are not listed, the Contractor shall request instructions from the Owner's Representative as to the class of material involved and the method of fabricating it before ordering any material. All steel lines 2-1/2" and larger shall be assembled by welding. All steel lines 2" and smaller may be assembled either by welding or by screwed fittings as specified.

B. Welding shall be done by mechanics who satisfy qualification requirements of the American Welding Society. The pipe ends to be welded shall be machine beveled wherever possible. Gas cuts shall be true and free from all burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no metal shall project within the pipe. Miter joints will not be allowed in any case. All headers, connections, elbows, reducers, flanges, and special flanges and special fittings shall be made using forged steel welding fittings of the same weight as the pipe to which they are attached. All unions and connections to valves 2-1/2" and larger shall be made by the use of welded flanges.

C. The location, direction, and size of all lines are generally indicated on the drawings. Branch connections in general are indicated and shall be so installed as to provide for proper grading and overall system drainage.

D. All lines shall be made up straight and true at proper grades. All water filled and drain lines shall be graded down toward suitable drains.

E. Piping shall follow as closely as possible the routes shown on the plans and take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

F. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and where lines are anchored.

G. Dielectric couplings shall be installed where ferrous pipe joins copper lines and shall be rated for the intended medium pressure and temperature or service.

H. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted. All fittings shall be fully manufactured.

I. Swing joints or expansion loops shall be provided wherever shown on the Drawings or wherever it is necessary to allow for the expansion and contraction of piping. This shall be accomplished in an approved manner and the piping system installer shall be responsible for any damage which may occur as a result of expansion and contraction of piping installed.

J. Keep all open ends of piping in each system plugged or capped to prevent dirt or other debris from entering the pipe at any and all times during construction and before fixtures, equipment, or other piping is connected thereto. All piping shall be flushed clear prior to connection to the central building systems.

K. The ends of all piping furnished and installed in all systems shall be thoroughly reamed to the full inside diameter of the respective pipe, as applicable.

L. All piping shall generally be run parallel with, and perpendicular to building lines and wherever possible shall be grouped together for easy service, location, and identification. Whenever possible, horizontal and vertical runs shall be held as close as possible to the walls, support members, etc., so as to occupy the minimum amount of space consistent with the proper installation requirements for insulation, supports and the expansion requirements of each of these items and the building proper or the removal of the respective or adjacent pipes and conduits; and to allow for necessary access to valves, other pipes, conduits, etc.

M. Valves required for control or isolation of any part of the various systems shall be provided and shall be located in approved or accessible positions and where several valves are related as to function, they shall be grouped together. Request approval from Owner's Representative for proper location of all valves.

N. All shut-off and isolation valves shall generally be installed with valve stems pointed vertically upwards. In no case shall valve stems be pointed downwards or less than in a horizontal position. Chilled water system valve stems shall not point less than 45 degrees below vertical in any case.

O. Where new lines are indicated to connect into existing lines, careful coordination shall be exercised to determine exact elevations and locations of existing lines, to establish grades of interconnecting new lines, to establish procedures to interconnect lines, and to establish other details.

3.2 CROSS CONNECTION AND INTERCONNECTIONS

A. No plumbing device or piping shall be installed which will provide a cross connection or interconnection between a distributing water supply for drinking or domestic purposes and a polluted supply such as drainage system, or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water, or waste into the water supply system.

3.3 EXCAVATION AND BACKFILLING

A. Provide necessary excavating and backfilling for the installation of work specified in this Division as specified in Section 23 05 00 and 00 23 00.

B. Trench safety shall be the responsibility of the piping system installer.

3.4 PRE-INSULATED PIPING SYSTEM INSTALLATION

A. Provide factory pre-insulated straight pipe and fittings, which shall be pre-fabricated to field verified job site dimensions to minimize the number of field cuts required. Field engineered systems shall be provided with factory insulated straight pipe sections and factory pre-fabricated fittings.

B. Underground systems shall be buried in a trench of not less than three (3) feet deeper than the top of the pipe and not less than eighteen inches wider than the combined O.D. of all piping systems. A minimum thickness of 24 inches of compacted select backfill shall be required over the top of the pipe. Backfill shall meet H-20 highway loading requirements. Due to other competing utility services in the vicinity of these piping systems, such as storm and sanitary sewer lines , natural gas lines, telecommunications cabling and electrical conduits/feeders, these piping systems will likely need to be located approximately 4'-0" to 5'-0" below grade in the instances where such utilities cross each other.

C. Trench bottom shall have a minimum of 6" of sand, gravel, or clean, select fill material as a cushion for the piping. Refer to Site Soils Test Report for recommended backfill requirements. All field cutting of the pipe shall be performed in accordance with the manufacturer’s installation instructions.

D. Where underground piping crosses the perimeter building foundation, native soil backfill shall be used for a minimum of 2’’0” on each side of, and under, the foundation, and 2'-0" on all sides of the pipe at these locations, as recommended by the Site Soils Test Report to prevent moisture migration in piping trenches to underneath the foundation following construction (a clay like plug).

E. Provide anchors or thrust blocks at all changes in direction, such as, but not limited to, 90 degree and 45 degree elbows, or offsets, in accordance with the soil conditions encountered and the piping system manufacturer’s recommendations, as applicable and as shown on the Drawings. Provide anchors for aboveground piping where shown.

F. A hydrostatic pressure test of the carrier pipe shall be performed at one and one-half times the normal system operating pressure expected, but not less than 100 PSIG, for not less than (2) two hours. Care shall be taken to insure all trapped air is removed from the system prior to the test. Appropriate safety precautions shall be taken to guard against possible injury to personnel in the event of a failure. All thrust blocks and pipe anchors shall be completely installed prior to commencing with this testing.

G. Provide for expansion and contraction of the piping system in accordance with the piping system manufacturer’s recommendations. Fully illustrate locations and details on pipe shop drawings for review and approval.

H. Pipe manufacturer shall provide field service via a certified manufacturer’s representative or company field service technician. Technician shall be at the project site a minimum of two (2) 1/2 day periods to check unloading, storing, handling of pipe, pipe installation, pressure testing, field joint installation and backfilling techniques.

3.5 UNDERGROUND PIPING PROTECTION

A. Protect the entire surface of all underground steel piping, fasteners, etc. against rust and corrosion.

B. For piping and nuts and bolts, such as those on mechanical joint piping systems, not specified elsewhere herein to be furnished with factory applied pipe corrosion resistant wrapping, the piping and fastener

surfaces shall be cleaned of rust, dirt, etc., with a wire brush and shall be free of oil and grease and be completely dry.

C. Brush on, or otherwise apply as recommended by the manufacturers, a heavy full coating of TC Mastic (Tape Coat Company, Evanston, Illinois) or Reilly Protective Tar Enamel No. 3302 (Reilly Tar and Chemical Company, Indianapolis, Indiana). Dry coating shall be not less than twelve 12 mils thickness. Protect freshly covered surfaces from dirt or moisture for at least 12 hours as recommended by the manufacturer to allow it to dry before backfilling. Depending on the weather the systems may be carefully backfilled as determined by the Owners representative.

3.6 TESTING AND REPAIRING

A. During the progress of each portion of the work or upon its completion, make such tests of this work as herein specified, or as required by the Engineer, or by the State or Municipality having jurisdiction and under their supervision.

B. Provide all apparatus, temporary piping connections, or any other requirements necessary for such tests. Take all due precautions to prevent damage to the adjacent buildings, sidewalks, lights, trees, landscape irrigation sprinklers, etc., incurred by such tests as all damage will be required to be repaired and made good, at no cost to the Owner. Testing of piping to be insulated shall be satisfactorily completed before insulation is applied.

C. Perform any other tests as may be required by the Owner's Representative to indicate the fulfillment of specification requirements.

D. All water piping shall be hydrostatically tested to a pressure of 100 psig or to 1-1/2 times the operating pressure, whichever is the greatest, for not less than four (4) hours.

E. Any leaks that develop or which are discovered shall be made tight and the test repeated. Test pressure shall not be applied to specialties, but joints shall be tested for leaks at the expected system operating pressure when complete.

F. Systems shall be tested in portions as required by the construction schedule and the portions being tested shall be effectively isolated and sealed off. When previously tested sections are connected into other sections, tests shall be rerun to include the new connections.

G. Partial systems shall be tested prior to connecting into existing lines.

H. Leaks in welded joints shall be repaired by chipping out the weld around the leak and re-welding until the leak is stopped. A leak in a compression joint shall be repaired by remaking the joint using a new seal, compression ring, coupling, etc., as required. Leaks in soldered joints shall be repaired by remaking the joint and no soldering or brazing over existing joints will be permitted. Any defective piping shall be replaced.

I. Additional testing shall be as specified in other individual Sections of these Specifications.

J. During testing and cleaning of piping systems, use a fine mesh, 20 mesh or smaller, start-up strainer screen for all strainer pipe sizes. After piping system is cleaned each strainer shall be taken apart, cleaned, and final strainer mesh shall be placed back in strainer for normal operating conditions.

K. Refer to Specification Section 23 25 13, HVAC Water Piping Systems, for chemical cleaning and treatment of new piping systems.

3.7 SEALING PENETRATIONS

A. Seal all pipe and duct penetrations through walls, structure, and floors. Fill the annular space between the insulation on the pipe, or the pipe only where uninsulated, and its sleeve, with neoprene or non-hardening sealant.

B. No pipe shall be allowed to contact its surrounding sleeve or the wall, floor, or structure. Effective isolation shall be provided as described in Section 23 05 48 to the end that no vibration or direct noise transmission shall be transmitted. Vibration transmission limits shall be as established in Section 23 05 48. Use special materials as may be required to comply.

C. Firestop pipe floor, structure, and wall penetrations as specified in Section 07 84 00 and 23 05 00.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other divisions for coordination of work with other portions of Work.

1.2 SYSTEM DESCRIPTION

A. Furnish and install all piping of every kind required, specified, or shown on the Drawings for the installation of the work specified in Division 23. The location, direction, and size of the various lines are indicated on the Drawings. Lines for pilot and controls and instrumentation are not shown but shall be installed as required and as specified.

B. Piping systems shall include all appurtenances shown on the drawings and specified herein.

C. Valves or cocks shall be installed to control the flow of water to each of the various systems, to segregate individual items of equipment and parts of fluid circulating or supply systems, and to permit draining of systems or portions thereof, to blow-off strainers, etc., as directed on the Drawings and specified.

D. The work shall include the furnishing and installing of all supporting structures and members for pipes, ducts, and equipment.

E. Support devices and members shall include vibration and noise isolating devices and assemblies. Penetrations of walls to structure shall be sealed off to limit noise transmission through sleeves.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed by experienced mechanics certified and trained for the work performed.

1.4 SUBMITTALS

A. Product Data: Submit complete manufacturer's descriptive literature and installation instructions in accordance with Section 01 33 00 for all piping materials to be used for each system, valves and hydronic specialties as specified herein.

B. Shop Drawings:

1. Submit in accordance with Sections 01 33 00 and 23 05 00.
2. Submit 1/4" = 1'-0" Scale HVAC and Plumbing Piping Shop Drawings.
3. Overlay piping Shop Drawings over other Shop Drawings of other trades to include electrical and sheet metal Shop Drawings.
4. Plan views of congested areas and sections thereof shall be drawn at a scale of 3/8" = 1'-0".

C. Fully coordinate all piping shop drawings with sheet metal shop drawings and other trades. Failure to submit shop drawings in a timely manner, as required to keep pace with the construction and work of all other trades, will result in delays, and possible stoppage, of payment to the Contractor. Additionally, no

work may proceed until such shop drawings are submitted, reviewed, and found to be acceptable by the Engineer.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

C. Take special precautions to protect control valve internals from construction dirt and debris. If valves are stored on site cover valve openings until just prior to installation but in no case shall valves be unprotected for more than 48 hours.

D. Openings in piping system, coil headers, boilers, pumps, valves and other heat exchangers shall be covered during the construction period to protect the interior accumulation of dirt and debris in these systems until immediately prior to connection to these components to similarly protected systems.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. In general, the following listed materials shall be used in fabricating the piping systems. Where special classes of piping are involved and are not listed, the Contractor shall request instructions as to the class of material involved and the method of fabricating it before ordering the materials. Steel pipe 2-1/2" and larger shall generally have plain ends to be assembled by welding and pipe 2" and smaller shall generally have screwed ends, except where special requirements dictate otherwise.

1. Chilled and Heating Water Lines:
    a. Schedule 40 black steel pipe conforming to ASTM A-53, Type “F” for sizes 2" and smaller, and Grade “B”, Type “ERW, for all sizes 2-1/2" and larger. Piping 12" and larger in Central Plant Chiller and Boiler Rooms shall be Schedule 40 in wall thickness. Piping 12" and larger outside the Chiller and Boiler Plant may be standard weight piping.
    b. For pipe sizes two inches (2") and smaller the Contractor may use Type "L" copper, with soldered joints, in lieu of threaded black steel pipe, using dielectric unions as specified elsewhere herein.
2. Miscellaneous drains from Air Handling Units, Fan coil units, Pump Bases, strainer blow-offs, backflow preventors and compression tanks: Type "M" or DWV (1-1/4" and larger) hard drawn copper.
3. Miscellaneous Lines: Pilot, bleed, control, sampling, and equalizing lines, and similar auxiliary lines shall be fabricated of the material used in the system to which they are connected in each case. Drains from appurtenances installed in copper lines shall be of Type "L" hard drawn copper tubing. Drains from air vent valves installed in steel piping systems shall be Schedule 40 black steel pipe. Other drains shall similarly match the piping system materials.
4. Chemical treatment piping and valves shall be Schedule 80 PVC or Type "L" hard drawn copper, up to final connections to the main system which shall be schedule 40 black steel or Type "L" hard drawn copper.
5. Refrigerant Piping: Type "ACR" hard drawn copper with 15% Silfos Solder joints. Refer to Section 23 23 00, Refrigerant Piping.
6. Condensate drains from cooling coils: Type “M” or DWV (1-1/4” and larger) hard drawn copper.
7. Condensate drain lines with Pro-Press type fittings: Type “L” hard drawn copper tubing.

B. Steel pipe shall be made and tested in accordance with the latest edition of the "Standard Specifications for Welded Steel Pipe" of the National Tube Company, or Youngstown Sheet and Tube Company. Piping 2" and smaller shall be manufactured by LeClede, Sawhill, or Wheatland. Piping 2-1/2" and larger shall be manufactured by Tex-Tube, Paragon, U.S. Steel, Wheatland or Armco. Unless otherwise specified, all pipe shall be Schedule 40 of ASA Standard B36.10.

C. In general, fittings used for the various piping systems shall be as listed below. Special fittings shall be used where required by job conditions and when approved for particular use.

1. Welding Fittings: All fittings in welded lines shall be factory fabricated welding fittings of the same material and the same schedule or weight as the piping system in which installed.

a. All elbows, reducers, tees, caps and special fittings shall be standard factory fabricated butt welding fittings, conforming to ANSI B16.9, with the following exceptions: Branch takeoffs from lines 2-1/2" in size and larger and where the size of the takeoff does not exceed two-thirds of the nominal diameter of the mains to which connected may be made with shaped nipples or with Bonney or Grinnell Weldolets or Threadolets as required by the class of fabrication. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

b. Welding fittings shall be Weldbend Corporation, Tube Turn, Hackney, or approved equals. Welding and fittings shall have the same bursting pressure as pipe of the same size and schedule. All elbows shall be the long radius type unless noted otherwise.

D. Screwed Fittings in Steel Lines: 150 lb. black malleable iron banded pattern screwed fittings made by Grinnell Company, Crane Company, or Walworth Company. All screwed fitting elbows shall be the long radius type unless noted otherwise.

E. Fittings for copper tubing shall be Chase Sweat Fittings, Nibco, Elkhart, or Mueller Brass Company's "Streamline" type solder fittings. Drainage type fittings shall be used wherever possible in drainage systems only. All solder for copper tubing shall be 95-5, Silfos or Eutectic No. 180F. All piping shall be installed according to the manufacturer's instructions. All joints shall be thoroughly cleaned before connecting. Silfos solder shall be used on all refrigerant piping. All elbows shall be the long radius type unless noted otherwise.

F. Miscellaneous Fittings: Provide all reducers, increasers, adapters, bushings, etc., as required to properly inter-connect the various items, to change sizes, etc. Steel fittings shall be used in steel lines, and copper and red brass fittings shall be used in copper lines.

G. As an alternate to standard sweat fittings for copper tubing, Pro Press type fittings shall be allowed for all drain lines as follows:

1. 3” and smaller, wrought copper. Press fittings, or ASME 16.2.2, ASME 15.18 sealing with EPDM sealing element for ½” to 2” and ProPress XL for 2-1/2” to 3.

H. **All piping materials and fittings shall be manufactured in the United States**.

2.2 FLANGES

A. Flanges in welded lines for water systems shall be 150 pound forged steel, welding neck flanges, except where cast iron fittings are used as specified elsewhere in these specifications, and except as otherwise shown.

B. Flanges in screwed ferrous lines shall be 125 pound cast iron or 150 pound forged steel screwed flanges.

C. Where ferrous flanges connect to flat faced flanges on valves, items of equipment, etc., the companion flange shall be flush faced and where the flanges on items of equipment are raised face flanges, the companion flanges shall have raised faces.

D. Flanges in copper lines shall be solder joint type cast brass flanges.

E. Flange bolts and nuts shall conform to the applicable requirements of the latest edition of the Code for Pressure Piping.

F. Slip-on welding neck flanges are prohibited.

G. Flanges shall be Weldbend, Tube Turn, Hackney, or approved equals.

2.3 GASKETS

A. Install gaskets between flanges of all flanged joints. Where used with brass or bronze flanges or with flat face ferrous flanges, they shall be full face type. For all other flanges they shall be ring gaskets properly cut to fit within the inside edges of the bolts.

B. Gaskets in water lines shall be Garlock No. 24 Wire Insertion Red Rubber Sheet Packing, 1/16" thick and for any other systems use special materials suitable for the duty as recommended by their manufacturer.

2.4 INSULATING FITTINGS

A. Except that no dielectric fitting shall be installed in connections between copper or brass and sanitary cast iron waste, drain and vent lines, wherever an interconnection is made between ferrous pipes or vessel and copper tubing or brass pipe, or vice versa, install a dielectric fitting.

B. In lines assembled with screwed or soldered joints, use insulating couplings (unions) suitable for the intended service and where flanged connections are required, use insulating gasket material between flange faces, insulating grommets between bolts and holes in flanges and insulating washers under both bolt heads and nuts.

C. PVC couplings of any kind shall not be acceptable for insulating couplings.

D. Insulating fittings shall be suitable for the service medium, operating pressure and temperature. Fittings shall be rated for 1.5 times the normal system operating temperature and pressure in which installed.

E. Insulating fittings shall be as manufactured by EPCO, Watts, Zurn or Mueller Streamline.

2.5 VALVES

A. All valves of any one type shall be of the same make throughout and insofar as practicable all valves in a given category shall be of the same make.

B. All valves shall be so located as to be readily accessible for operation and maintenance.

C. Furnish and install all valves indicated on the Drawings, specified herein, and required to control the flow of water to and from various parts of the systems and to isolate various pieces of machinery and equipment and to isolate various parts of the systems.

D. Each valve for installation in a line to be insulated shall have sufficient clearance between the valve body and the operating handle or device to accommodate the insulation.

E. All valves shall be designed for re-packing under pressure when fully opened and shall be equipped with packing suitable for the service.

F. Valves shall generally be installed with stems up; but, in no case, less than horizontal and whenever possible shall be grouped together in a uniform manner.

G. Except where special valves are specified elsewhere herein or as required by special conditions or class of work, valves shall be equivalent to the following Crane Co. valve numbers listed herein.

H. All globes valves 2" and smaller shall be Class 150 rated to 200 degrees F. All valves 2-1/2" and larger shall be Class 125WP and 200WOG rated for 200 degrees F., be of the flanged design, be made of ASTM A 126, Class B, with bronze trim, and have an outside screw and yoke design.

1. Valves shall have rising stem, screwed or union bonnet and manufactured in accordance with MSS-SP-80.
2. Body and bonnet shall be manufactured of ASTM B-62 alloy or ASTM B-61 alloy.
3. All valves shall have ductile or malleable iron handwheels.

4. Stems shall be made of dezincification resistant silicon bronze ASTM B-371 or be low zinc alloy B-99.
5. All valves shall be suppled with non-asbestos packing, amarid fibers or approved equal.
6. Class 150 valves shall be one of the following:

    a. Nibco - T-235-Y.
    b. Crane - 7TF.
    c. Jenkins - 106BJ.
    d. Hammond IB413-T.
    e. Milwaukee 590T.

7. Class 125 valves shall be one of the following:

    a. Nibco - F-718-B.
    b. Crane - 351.
    c. Jenkins - 2342J.
    d. Hammond IR116.
    e. Milwaukee 2981A.

I. Where cocks are required, they shall generally be brass, screwed pattern up to 2" and cast iron flanged pattern 2-1/2" and larger plug cocks suitable for the system pressure. Also provide and install all special cocks required such as pet cocks, gauge cocks, etc.

J. Provide plug valves where indicated, at "all water balance stations" and at all pump discharges.

1. In no case shall butterfly or ball valves be substituted for plug valves where plug valves are indicated on the Drawings.
2. Valves shall be flanged-type, 2-1/2" and larger, and threaded 2" and smaller.
3. Plug valves 4" and smaller shall be equal to DeZurik (or SMG) Series 400 eccentric plug valves with cast iron bodies.
4. Plug valves over 4" in size shall be equal to DeZurik (or SMG) Series 100 eccentric plug valves with cast iron bodies.
5. Valves 4" or smaller shall have cast iron bodies with bronze plugs on sizes 2" and smaller and electroless nickel plated cast iron plugs on 2-1/2" to 4" valves.
6. Valves over 4" shall have cast iron bodies with stainless steel plugs and bearings.
7. All plugs shall have resilient faces rated for water temperatures up to 250 Deg.F. and stem seals meeting the same temperature rating. For general chilled and heating water applications, elastomeric coating shall be EPDM.
8. Furnish lever operator for all valves except at water coils of terminal units where snap-on plastic caps shall be furnished.
9. All valves shall have adjustable memory stops with plastic drip caps.
10. Plug valves shall be furnished with drilled and tapped 1/8" openings for pressure gauge connections at both upstream and downstream sides.
11. Plug valves shall be bubble tight with 150 pound differential pressure across the seat.
12. An indicator shall be included to show valve position.
13. All flanged plug valves shall have bolted bonnets.
14. All valve seats shall be welded in nickel for plug valves over 4" in size.
15. Plug valves shall be as manufactured by:

    a. DeZurik (or SMG).
    b. W-K-M.
    c. Rockwell-Nordstrom.
    d. Milliken.

K. Check valves in pump discharge lines shall be flanged non-slam type silent check valves. Valves shall have a cast-iron body and be bronze fitted with stainless steel springs. Valves shall be rated for 125 PSIG WOG and be one of the following products:

1. Nibco - F-910-B Series.
2. Combination Pump Valve (CPV) Manufacturing, Inc.- 20D Series.
3. APCO - 600 Series.

L. Swing Check Valves 2" and smaller shall be the Y-pattern swing-type manufactured in accordance with MSS-SP 80, and be Class 125 rated to 200 Deg.F. or below, have bronze ASTM B-62 bodies with bronze discs. Swing check valves 2" and smaller shall be of the following:

1. Nibco - T/S-413-B.
2. Crane - 37 or 1340.
3. Jenkins - 4037J or 997AJ.
4. Hammond - IR1124.
5. Milwaukee - 2974A.

M. Swing Check valves 2-1/2" and larger shall be the swing-type manufactured in accordance with MSS-SP71, be Class 125 rated for 200 Deg.F. or below, be flanged, have ASTM A126, Class B, cast iron bodies with bronze trim, and have non-asbestos gaskets. Swing Check valves 2-1/2" and larger shall be one of the following:

1. Nibco - F-918-B.
2. Crane - 373.
3. Jenkins - 588J.
4. Hammond - IB904.
5. Milwaukee - 509.

N. Contractor shall furnish butterfly isolation valves in chilled and heating water lines 2-1/2" and larger.

1. They shall have ductile iron bodies with aluminum bronze discs, 416 stainless steel shafts and shall be generally as specified for plug valves above as to materials, trim, tightness of closing, etc.
2. Liner shall generally be resilient EPDM with brass bushings and collar. Liner and seats shall be rated for 225 Deg. F at 150 PSIG.
3. Valves 2-1/2" and larger shall have lug bodies and resilient seating or have a resilient faced plug.
4. Valves shall be rated for end of line service, without the need for a downstream flange, and be bubble tight to a minimum of 150 PSI with bi-directional flows.
5. Where butterfly valves are used for balancing, only where shown, use infinite position lever lock handles with memory stops similar or equal to Nibco LD/WD 2000/3000. Valves shall be able to have the handles padlocked in the open, closed or balanced positions. Handles shall be polymer coated iron with lever lock and throttling plates made with zinc plated steel. No aluminum die cast lever handles allowed.
6. Valves 6" and over shall be provided with heavy duty cast iron hand wheel gear operator with indicator. Where these valves are also used for balancing provide with a memory stop. Provide with babbit sprocket (and chains) only where specified elsewhere herein. Operators shall be suitable for all weather conditions and shall be the self-locking worm gear type.
7. Provide two inch (2") extension necks for insulated lines.
8. Butterfly valves shall be as manufactured by

    a. Nibco LD Series in 2" - 12" sizes and LD1000-5 Series for 14" - 24" sizes.
    b. Dezurik (or SMG) BRS-C1-EPDM-EPDM-BZ-S4.
    c. Demco NE-C Series in 2" - 12" sizes and NF-C Series for 14" - 24" sizes.
    d. Keystone AR2 Series.
    e. Grinnell Series 8000.
    f. Apollo LD 141 Series.
    g. Milwaukee ML233E in 2"-12" sizes only; larger valves not allowed.

O. Contractor shall provide ball valves. In chilled, heating and domestic cold and hot water lines 2" and smaller, Contractor shall furnish ball valves without exception as follows:

1. Ball valves shall be on the following products (All bronze bodies only):

    a. Nibco T-585-70-66 or S-585-70-66.
    b. Apollo 77C-140 Series or 77C-240 Series.
    c. Hammond 8303-A or 8311-A.
    d. Milwaukee BA400 or BA4505 (Not allowed on chilled water systems).

2. Ball valves may also be used in lieu of plug valves for balancing purposes for lines 2" and smaller and only when provided with memory stops.

3. Ball valves shall be full port design with stainless steel ball and stem.
4. All ball valve body pieces and stems shall be manufactured from a dezincification resistant material with less than 15% zinc.
5. All ball valves shall have a threaded packing gland. Each ball valve will not require the handle and handle nut to be installed in order to keep the valve packing in place.
6. Provide memory stops where used for balancing or as shown and where detailed.
7. Provide extended lever handles for all valves installed in insulated lines.
8. Ball valves installed on chilled water piping shall be provided with an extended "T" handle with insulation insert and collar that creates a vapor seal to prevent condensation while allowing adjustment of memory stops and valve packing maintenance without disturbing the insulation. Insulated "T" handles shall be equal to Nib-Seal as manufactured by NIBCO. No extended metal handles are allowed.

P. Provide chain operators on all butterfly valves installed 10'-0" or higher above the finished floor with chains to extend to not lower than 7'-6" or higher than 8'-0".

2.6 PUMP SUCTION DIFFUSERS

A. Furnish and install as shown on plans, an angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, with flow straightening vanes, start-up strainer and adjustable support foot. The combination diffuser-strainer-orifice cylinder shall be designed to withstand a pressure differential equal to the system pump shutoff head (refer to pump schedule) and shall have a free area equal to five times the cross sectional area of the pump suction opening for the actual pumps to be used. The length of the flow straightening vanes shall be no less than 2-1/2 times the diameter of the system pump suction connection.

B. Pump Suction Diffusers shall be manufactured of Cast Iron and be Flanged Models Rated for a Maximum Working Pressure of 175 PSIG.

C. The flow straightening fitting shall be made of cast iron construction with Flanged system and Flanged pump connections. The fitting shall have a stainless steel combination diffuser-strainer-orifice cylinder with 3/16" diameter perforations to protect the system pump. The full length stainless steel flow straightening vanes shall provide non-turbulent flow to the suction side of the system pump.

D. Furnish a start-up strainer which consists of a 16 mesh bronze screen.

E. The support foot (supplied by Piping System Installer) shall eliminate pipe strain at the flow fitting/pump connection. All internal components shall be replaceable without removal of fitting.

F. Each suction diffuser/flow straightening fitting shall be ITT Bell and Gossett fully flanged models or approved equals only.

2.7 PIPE HANGERS

A. Pipe hangers, except for fire protection types, shall be as manufactured by Anvil International, Inc. and be of a type suitable for each use. Approved equals by Mason Industries, Inc., B-Line, Erico Caddy, and PHD Manufacturing, Inc. will be considered.

B. For cast-iron pipes up to three inches (3") in size, use Anvil Fig. 104 malleable iron, adjustable, split ring, swivel hanger, or Anvil Fig. 590 steel clevis hanger. For cast iron plumbing piping four inches (4") and larger, use only Anvil Fig. 590 steel clevis hanger.

C. Heating and air conditioning piping (chilled, heating and condenser water piping) 3/4" in size up to and including twelve inches (12"), shall be Anvil Fig. 260, adjustable clevis hangers. Hangers shall be sized to be on the outside of the insulation.

D. Where several pipes are routed parallel to each other and at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on rollers where rollers are called for elsewhere by these specifications.

E. For bare copper pipes (uninsulated only) up to and including three inches (3") in size, use Anvil Fig. CT-109 malleable iron, copper plated, split ring, hangers or Anvil Fig. CT-65 copper plated clevis hangers. For uninsulated copper pipes larger than three inches (3"), use Anvil Fig. CT-65 copper-plated clevis hanger.

F. Hanger rod sizes shall conform to the following schedule:

Pipe up to, and including 2"	3/8" rods
Pipe 2-1/2", 3", and 3-1/2"	1/2" rods
Pipe 4" and 5"	5/8" rods
Pipe 6"	3/4" rods
Pipe 8", 10" and 12"	7/8" rods
Pipe 14", 16" and 18"	1" rods
Pipe 20" up to 30"	1-1/2" rods

G. Unless shown otherwise on the Drawings, all horizontal runs of ferrous piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to, and including 1-1/4"	8 feet
Pipe 1-1/2" and 2"	10 feet
Pipe 2-1/2" and 3"	12 feet
Pipe 3-1/2" and 4"	14 feet
Pipe 5" and 6"	* 8 feet
Pipe 8" and larger	* 8 feet

* Maximum 8 foot spacing for pipe supports for pipes 5" and larger due to structural considerations.

H. Unless shown otherwise on the Drawings, all horizontal runs of copper piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to 3/4" in size	6 feet
Pipe 1" and 1-1/4"	8 feet
Pipe 1-1/2" and 2"	10 feet
Pipe 2-1/2" and larger	12 feet

I. There shall be a hanger within two feet (2') of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps. Vertical pipes within a space shall have not less than two (2) supports. Where the vertical run of pipe in a space exceeds 14 feet then three (3) supports shall be required.

J. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting; nor shall it be supported from equipment connections.

K. Inserts shall be used where piping or equipment is to be hung from concrete construction. Inserts shall be Anvil Fig. 281, wedge type, concrete inserts. All inserts shall be pre-treated to prevent rusting. After the forms are removed, clip off all nails flush with the exposed surface of the inserts.

L. Expansion bolts shall be Ackerman-Johnson.

M. Beam clamps suitable for the use with the type of steel construction involved shall be an Anvil product or an approved equal as indicated elsewhere herein.

N. No perforated straps shall be used to support any mechanical equipment item or piping of any kind.

O. Chilled water, heating water, domestic cold water, domestic hot water (includes recirculated lines), condensate drains, horizontal and vertical storm drain downspouts and soil piping receiving cold condensate piping hangers shall be sized to go around the insulation with shields being provided to protect the insulation. Shields shall be Anvil Fig. 167.

P. All steel hangers, base plates, supports, nuts, bolts, and all thread rod located outdoors, in crawl spaces, and exposed to the weather, shall be made of galvanized steel or equally suitable corrosion resistant steel alloy or aluminum. Where steel components are allowed and used under these conditions they shall be painted with an equivalent protective coating similar to a two-part epoxy. Refer to Section 09 90 00.

Q. For pipe sizes 8" and under use Anvil Fig. #93 and 94 beam clamps. For pipe sizes 10" through 18" use Anvil Fig. #66 in the “U” position.

2.8 SLEEVES AND ESCUTCHEONS

A. Generally where pipes pass through interior building walls or floors above the first floor (out of the ground), 22 gauge galvanized sheet metal sleeves shall be used. Sleeves shall extend a minimum one inch (1") above a floor or beyond the wall, as applicable.

B. All pipes penetrating grade beams, exterior walls, concrete structural members, or concrete slabs of mechanical equipment rooms on the first floor shall generally use standard weight galvanized steel pipe as the sleeving material.

C. For concrete or masonry walls, sleeves shall be inserted into the masonry, decking or form work prior to the pouring or placement of concrete or masonry units to create a leave out.

D. The sizes of all sleeves shall be such as to permit the subsequent insertion of the intended pipe of the proper size with adequate clearance for movement due to expansion and contraction. In the case of insulated lines, the diameter of the sleeves shall be at least 1/2" greater than the outside walls of the pipe with specified thickness of insulation. This will require that the inside diameter of galvanized steel pipe sleeves be at least 1/2" greater than the outside diameter of the service pipe with insulation. Galvanized steel pipe sleeves set in floors shall project two inches (2") above the floor.

E. After the pipes are installed, fill the annular space between the pipe, and insulation as required, and its sleeve with an approved mastic or caulk. Use loose fibrous insulation packing as required to accomplish this. In all cases the annular spaces around the pipes within the sleeved openings shall be filled with loose fibrous insulation and then sealed with an approved caulking or expanded foam insulation.

F. Escutcheons, except as specifically noted or specified, shall be installed on all pipes passing exposed through floors, walls, or ceilings. Escutcheons shall be equal to the Crane No. 10, chrome plated sectional floor and ceiling plates, and shall fit snugly and neatly around pipe or pipe insulation or insulated lines. Solid chrome plates with set screws shall be used if sectional plates do not fit properly or stay in place. Where multiple pipes penetrate floors or walls in close proximity in concealed areas, shop made sheet metal escutcheons may be used.

G. Pipes sleeved through grade beams open to basements, crawl spaces or void spaces below grade shall additionally receive "Link Seal" or equal closures made of interlocking synthetic rubber links. Seals shall provide for absolute water tightness. Seal shall be constructed to insulate electrically pipe from wall. Install as recommended by manufacturer. Provide Century-Line sleeves with water stop and anchor collar for pipes penetrating grade beams designated to be anchored.

H. Where PVC pipes, 3 inches and smaller, and small copper water piping under 2 inches in size, penetrated a horizontal floor slab a metal sleeve will not be required. For these piping systems, completely wrap the piping with a polyethylene tape, or wrapping. This tape shall be minimum 4 mils thick and shall be wrapped at least two times around the pipe and secured sufficiently to hold the wrap in place during the pouring of the slab. This wrap shall be in sufficient length or height to insure that no concrete will be in contact with the pipe. All other piping shall be sleeved as indicated elsewhere herein.

I. Refer to Section 23 05 00 for additional requirements of penetrations through fire-rated assemblies.

2.9 ACCESS DOORS

A. Wherever access is required above inaccessible ceilings, in walls, furrings, chases or soffits to physically reach concealed piping, ductwork, fire/smoke dampers or mechanical equipment installed under Division 23, provide access doors of sufficient size to maintain, repair, replace or suitably access devices intended to be adjusted as indicated herein.

B. Provide an access door or panel for each of any valves, group of valves, damper pull rods, splitter dampers, manual volume dampers, actuators or other controlling mechanism installed under Division 23 which would otherwise be concealed in the building construction with no access.

C. All access doors in toilet rooms, locker rooms, showers, kitchens, or other similar wet areas shall be the flush mounted type and be made of brush or satin finish stainless steel as manufactured by Milcor.

D. All access doors shall be minimum 12" x 12" in size unless otherwise approved in writing in advance by the Engineer. Doors shall be increased in size as required to allow for a person to reasonably access, adjust, maintain, service, inspect or replace the largest single component concealed. Provide special sizes of access doors as required.

E. Coordinate the final location of all concealed equipment and devices requiring access with the final location of the required access panels or doors. Allow ample space for the removal of all parts and equipment that require replacement or servicing.

F. Where mounting heights are not detailed or dimensioned, install mechanical piping and overhead equipment to provide the maximum headroom possible while maintaining reasonable access and service to those items being accessed.

G. Extend all equipment grease fittings to an accessible location which shall be within reach (maximum of 18") from the access door.

H. Install all access doors in locations to suit the intended purpose but have each location reviewed and approved by the Architect. In no case shall access doors be located such that the intended purpose is rendered useless.

I. Access doors shall all have spring concealed hinges, screwdriver operated cam latches, be the flush mounted type, open up to, but not more than, 175 degrees, be made of steel, or stainless steel to suit the application, be fire rated (U.L. rated) to match the rating of the surface where the door is placed, and have a powder coated electrostatic primer paint on all steel doors. Furnish the following access door types as described below:

1. Milcor Style DW - Flush drywall type with frame made of 16 gauge steel, panel door made of 14 gauge steel, galvanized steel drywall bead on frame, and removable hinge pins for removal of panel door. Provide minimum of two hinges (12" x 12" and larger) up to 24" x 24" in size and three hinges on access doors above this size. Provide one cam for access doors 14" x 14" and smaller and a minimum of three cams on larger sizes.
2. Milcor Style K - Flush plaster wall or ceiling type made similar to Style DW except with a 22 gauge expansion casing bead, one hinge on 12" x 12" access doors, two hinges on larger doors with either side no larger than 24", three hinges on doors with any dimension of 24" or larger, minimum one cam on doors with no dimension larger than 18" and two or more cams on larger access doors.

3. Milcor Style M or MS - Flush drywall, masonry or tile type made similar to Style DW except with 14 gauge steel frame and doors (16 gauge when made of stainless steel-satin finish), one hinge on access doors up to 18" x 18" in size, two hinges on sizes 20" x 24" and 22" x 22", three or more hinges on sizes 24" x 24" and larger, and the number of cams as standard with the manufacturer.
4. Provide other types of access doors suitable for the application to include surface mount, double leaf for access doors exceeding 36" in any dimension, louvered where indicated on the Drawings, fire rated, recessed or security/detention types as required and compatible with the surface penetrated.

2.10 STRAINERS

A. Strainers shall be of the "Y" pattern type bodies, unless shown or specified otherwise. Body ends shall be screwed or flanged to match the type of joints in the piping in which the strainers are installed. Strainers shall have a 125 lb. ANSI pressure rating except that steam and steam condensate, gravity or pumped, system strainers shall be rated for 250 lb.

B. Each strainer, screen, or mesh shall be of Type 304 Stainless steel, brass, or monel construction. Screen or mesh sizes shall be as scheduled below:

Pipe Size	Screen/Mesh Size
1/2" - 2"	20 Mesh
2-1/2" - 3"	0.045 Perforations
4" - 12"	0.125 Perforations

C. Where vertical space does not permit the installation of the "Y" strainer, install an equivalent basket strainer.

D. Where strainers are used in domestic water supply systems they shall be coated (all wetted parts) with an FDA approved epoxy coating.

E. Strainers for screwed piping shall be Sarco Type IT (cast iron body) with optional bronze plug for steel piping or Sarco Type BT (cast bronze body) for copper piping; for flanged piping shall be Sarco Type CI-125 or F-125 and CI-250 or F-250 (cast iron bodies) as suitable for the pressures and temperatures encountered. Equivalent as manufactured by the following will be considered:

1. Grinnell.
2. Crane.
3. Lesley.
4. McAlear.
5. Keckley.
6. Mueller.
7. Nibco.

2.11 GAUGES AND GAUGE COCKS OR NEEDLE VALVES

A. Provide the following pressure gauge cock or needle valve connections:

1. At the suction and discharge of each water pump.
2. At the inlet and outlet of each water coil.
3. At the inlet and outlet of each heat exchanger and evaporator.
4. At the inlet and outlet of pressure reducing stations.
5. At water balance stations and any other points indicated or detailed on diagrams on the Drawings.

B. Where gauge connections are installed in insulated lines, install gauge cocks or needle valves on a nipple of sufficient length that the gauge cock or needle valve handle will be free of the pipe insulation. Position each gauge cock in relation to surrounding piping and equipment so that the gauge may be easily read and so that a gauge having a 4-1/2" diameter dial can be screwed into and out of the piping nipple where

the gauge cock or needle valve is installed. All gauge cocks shall be of the tee-handle type. Needle valves shall be a Weksler AV32, AV34, or BBV4.

C. Install gauge cocks or needle valves at pumps at the pump suction and discharge flange connections at the pre-drilled and tapped gauge connections as provided by pump manufacturer.

D. Furnish and install a pressure gauge suitably calibrated at each of the following locations:

1. The suction and discharge of each water pump.
2. The water line entering and leaving each heat exchanger and evaporator.
3. At the inlet and outlet of each pressure reducing station.
4. At other points indicated on the Drawings.

E. Gauges shall be of the bourdon tube type, and shall be selected to operate at about the midpoint of their full range, i.e., for a 50 PSI operation, select a gauge of 0 to 100 psi. Accuracy shall be +/- 1%. Each gauge shall be provided with a brass lever handle union cock or brass handle needle valve. Cases shall be Phenol or Steel, not less than four and one-half inches (4-1/2") in diameter.

F. Pressure gauges shall be equal to Weksler "Regal" series Industrial gauges with an aluminum safety case with bottom or lower connection, phosphor bronze bourdon tube with brass socket and all 300 Series stainless steel movement, 4-1/2" white enameled aluminum dial with black graduations and numbers on a 270 degree arc, 1/4" male NPT thread size; and be equipped with a geared micrometer adjustment pointer (balanced). Provide each gauge with scale range suitable for the duty. Gauges shall be Weksler Model BA14 or equal.

G. Provide pulsation dampeners, adjustable snubbers, or piston type pressure snubbers in line with all pump gauges.

H. Cocks and gauges shall be manufactured by:

1. Weksler.
2. Trerice.
3. Weiss.
4. Miljoco.
5. Marsh.
6. Crosby.

2.12 THERMOMETERS AND THERMOMETER WELLS

A. Furnish and install brass or stainless steel closed separable thermometer wells for all thermometer and controller bulbs which are designed for liquid measurements. Whenever a thermometer or controller bulb is inserted in a pipe for either remote or local temperature indication or control, locate the thermometer well so that it will be completely surrounded by flowing fluid. Such thermometer locations as are shown on the Drawings are diagrammatic only. Install thermometer wells for maximum effectiveness and in the case of locally indicating instruments, for easy readability.

B. Supply each brass test well for use with the stem thermometers, a threaded brass plug and keeper chain. Install these test wells in the following locations such that they can be filled with oil to facilitate temperature measurements:

1. At the inlet and outlet of each water coil.
2. At the inlet and outlet of each heat exchanger and evaporator.
3. At the discharge of each modulating 3-way control valve.
4. At other locations as specified herein or shown on the Drawings.

C. Where thermometer wells are called for, furnish and install brass wells with the tip of the well extending into the water stream. The well shall have a plug attached to it with a short length of chain. The wells shall be installed in the vertical or at 45 degree angle up.

D. Thermometers shall be of the industrial type with red spirit filled liquid (no mercury allowed), bronze enameled aluminum cases, glass fronts, 9" scales, separable sockets; straight or angle pattern so selected that they can be read from the floor. Straight type equal to Weksler Type 105 and angle type equal to Weksler Type 115, Type 125, or Type 135, depending upon the angle and aspect. Furnish thermometers with 2-1/2" stem extensions where they are installed in insulated lines. Select scale ranges for maximum readability at the design temperature of the medium being measured.

E. Thermometers shall be installed in the following locations:

1. At the discharge of each pump or Blending Station valve.
2. At the inlet and outlet of each heat exchanger, evaporator and condenser.
3. At other locations as specified herein or shown on the Drawings.

F. In lieu of the industrial stem type thermometers 5" dial silicon filled bi-metal thermometers with vari-angle feature or “solar only” self powered digital thermometers (no batteries allowed) with sealed sensor technology, minimum 1/ 2" tall LCD digit size display, 1% accuracy, and variable angle stem assembly shall be allowed.

G. Thermometers and thermometer wells shall be as manufactured by:

1. Weksler.
2. Trerice.
3. Marsh.
4. Taylor.
5. Miljoco.
6. Weiss.

2.13 TEMPERATURE AND PRESSURE TEST PORTS

A. Temperature and Pressure Test Ports, or Pete’s plugs, shall be dual valve type with valve pocket between valves, retaining cap with gasket and cap "saver" connector.

B. These ports may be used at water coil connections in lieu of gauge cocks or needle valves and thermometer test wells.

C. Pete’s plugs shall have the pipe nipple extended to beyond the insulation thickness to make the plug fully accessible and a minimum of one inch (1") above the pipe insulation.

D. Ports shall be as manufactured by:

1. Pete.
2. Autoflow.
3. Flowset.

2.14 AUTOMATIC FLOW CONTROL VALVES

A. Valves shall be rated for up to 200 psi and 200 Deg.F.

B. Body shall be of wrought copper, brass or ductile iron construction with AISI Type 300 series passivated stainless steel parts, electroless nickel plated brass, and 17-7 PH spring.

C. Provide label on body to indicate flow rate, model number, PSID range and flow rate. Information shall be on minimum 3" x 3" aluminum tag.

D. Flow shall automatically be controlled within + 5% of rated flow.

E. Provide Y-Type strainers with blowdown valve upstream of all flow control valves made of bronze or cast iron with a bronze or cast iron cap rated for temperature and pressure same as valve. Screen shall be stainless steel with 0.055 inch diameter holes. Refer to Para.2.9, Strainers.

F. Provide brass P/T ports with extensions for insulated piping for each flow control valve.

G. Automatic flow control valves shall be as manufactured by:

1. Griswold Controls.
2. "Autoflow" by Flow Design, Inc.

H. It is the intent of this article to specify single devices which will be field piped per Schematics shown on the Drawings. Pre-piped assemblies of multiple piping accessories are not allowed, unless otherwise indicated elsewhere herein.

2.15 RELIEF VALVES

A. All closed water systems shall be protected with a relief valve. Valves shall be spring operated, all brass, and shall meet A.S.M.E. requirements for discharge capacities. Discharge lines shall be piped to the nearest floor drain.

B. Relief valves shall be as manufactured by Watts, Klipfel, McAlear, or McDonnell and Miller.

C. Provide atmospheric relief piping routed to the outdoors as required by local code for all steam and natural gas systems.

2.16 AIR VENTS

A. Provide and install air vents, air eliminators, where shown and at any high points or traps in water circulating lines where air might collect.

B. Each such air vent shall be installed with a valve at its inlet and shall discharge through an integral check valve. The waste lines from the discharge from air vents shall be collected and piped to the nearest floor drain in each case.

C. All automatic air vents shall have cast or ductile iron bodies with corrosion resistant bolts, Buna-N or EPDM seating materials to meet system pressure and temperature requirements, and all stainless steel internal control components.

D. Provide manual air vent cocks, or needle valve, for all water coils where not integral or supplied with coil by manufacturer.

E. Automatic air vents shall be rated for a maximum working pressure of 150 psig and 250 Deg.F.

F. Automatic air vents shall be as manufactured by:

1. Hoffman Model No. 792.
2. Armstrong Model No. AV.
3. Bell & Gossett Model No. 107A.
4. Or equivalent by Amtrol.

PART 3 - EXECUTION

3.1 PIPING - GENERAL

A. Where special classes of piping are involved and are not listed, the Contractor shall request instructions from the Owner's Representative as to the class of material involved and the method of fabricating it before ordering any material. All steel lines 2-1/2" and larger shall be assembled by welding. All steel lines 2" and smaller may be assembled either by welding or by screwed fittings as specified.

B. Welding shall be done by mechanics who satisfy qualification requirements of the American Welding Society. The pipe ends to be welded shall be machine beveled wherever possible. Gas cuts shall be true and free from all burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no metal shall project within the pipe. Fully ream, to the full inside pipe diameter dimensions, the inside of all piping to be welded. Miter joints will not be allowed in any case. All

headers, connections, elbows, reducers, flanges, and special flanges and special fittings shall be made using forged steel welding fittings of the same weight as the pipe to which they are attached. All unions and connections to valves 2-1/2" and larger shall be made by the use of welded flanges.

C. Branches in lines where the branch side is equal to 2/3 of the size of the main or smaller may be connected by using Weldolets or Threadolets; where the sizes are greater than 2/3 of the main, standard weight seamless tees as manufactured by Tube-Turns or Grinnell, A.S.T.M. Standard A-234 shall be used.

D. The location, direction, and size of all lines are generally indicated on the drawings. Branch connections in general are indicated and shall be so installed as to provide proper grades.

E. All lines shall be made up straight and true at proper grades. All water filled and condensate drain lines shall grade down to drains.

F. Piping shall follow as closely as possible the routes shown on the plans and take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

G. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.

H. All headers shall be assembled as indicated using welding fittings throughout.

I. All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with graphite and oil applied to the pipe threads only and not to the fittings.

J. Dielectric couplings shall be installed where ferrous pipe joins copper lines and shall be rated for the intended medium pressure and temperature or service.

K. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of systems. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items or coils, machinery items and other special pieces of apparatus. Unions in 2" and smaller lines shall be ground joint and unions 2-1/2" and larger shall be flanged unions. Unions shall be the same material and strength as other fittings in the lines. Companion flanges on lines at various items of equipment, machines, and pieces of apparatus shall serve as unions to permit removal of the particular item.

L. All piping shall be supported by hangers independently of equipment connections. The weight of the piping and its contents shall not be imposed on the equipment in any way.

M. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

N. Swing joints or expansion loops shall be provided wherever shown on the Drawings or wherever else necessary to allow for the expansion and contraction of piping. This shall be accomplished in an approved manner and this Contractor shall be responsible for any damage which may occur as a result of expansion and contraction of his piping.

O. Nipples shall be of the same size and material as the piping in the system in which the nipples are installed, except that "close", or "all thread" nipples shall not be used.

P. Keep all open ends of piping in each system plugged or capped to prevent dirt or other debris from entering the pipe at any and all times during construction and before fixtures or equipment is connected. All piping shall be flushed clear prior to connection to the central building systems.

Q. The ends of all piping furnished and installed in all systems shall be thoroughly reamed to the full inside diameter of the respective pipe.

R. Exposed and concealed lines shall be run parallel with, and perpendicular to building lines and wherever possible shall be grouped together for easy service and identification. Whenever possible, horizontal and vertical runs shall be held as close as possible to the walls, ceilings, struts, members, etc., so as to occupy the minimum space consistent with the proper installation requirements for insulation, conduit, ductwork, lighting fixtures, etc., and the expansion requirements of each of these items and the building proper or the removal of the respective or adjacent pipes, conduits, and ductwork, and to allow for necessary access to valves, other pipes, conduits, dampers, etc.

S. Valves required for control or isolation of any part of the various systems shall be provided and shall be located in approved or accessible positions or made accessible through removable panels, etc., and where several valves are related as to function, they shall be grouped in a battery. Request approval from Owner's Representative for proper location of all access panels required for valves, etc.

T. All automatic control valves shall be installed such that the valve stem is pointed upwards, vertical, and in no case shall it be mounted at less than a 45 degree angle from the vertical position unless specifically approved by the Engineer prior to installation. There will be no exception for chilled water type systems.

U. All shut-off and isolation valves shall generally be installed with valve stems pointed vertically upwards. In no case shall valve stems be pointed downwards or less than in a horizontal position. Chilled water system valve stems shall not point less than 45 degrees below vertical in any case.

V. Where new lines are indicated to connect into existing lines, careful coordination shall be exercised to determine exact elevations and locations of existing lines, to establish grades of interconnecting new lines, to establish procedures to interconnect lines, and to establish other details.

W. Pre-assembled water coil piping assemblies are not allowed unless specifically indicated otherwise elsewhere herein. The intent of these Specifications is to have individual piping valves and specialties field assembled per the Schematic Diagrams illustrated on the Drawings and to meet all other installation requirements indicated elsewhere herein.

3.2 CROSS CONNECTION AND INTERCONNECTIONS

A. No plumbing fixtures, device, or piping shall be installed which will provide a cross connection or interconnection between a distributing water supply for drinking or domestic purposes and a polluted supply such as drainage system, or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water, or waste into the water supply system.

3.3 EXCAVATION AND BACKFILLING

A. Provide necessary excavating and backfilling for the installation of work specified in this Division as specified in Section 23 05 00 and 31 23 00.

3.4 FLASHINGS

A. Flash around all pipes passing through the roof with sheet lead, as specified in Section 07 52 50, built a minimum of 10" into the roofing, in all directions from the outside of the pipe running up the pipe a minimum of 10" and more where vent terminals must be higher to conform to the requirements of the local Plumbing Code in effect, and then turned over one inch (1") into the pipe cavity. All seams and joints shall be completely soldered closed and the entire flashing shall be completely waterproof.

B. Make all roof penetrations in accordance with the roofing system manufacturers approved methods and as specified in Section 07 52 50.

3.5 PIPE INSULATION INSERTS AND SHIELDS

A. Provide a section of Foamglas insulation, calcium silicate, or urethane of thickness specified at hanger support locations and provide No. 16 gauge galvanized steel protection shield minimum 12" long. Shield shall be full half cylinders equal to Grinnell Fig. 167.

B. Refer to Section 23 07 00, Insulation.

3.6 SAFETY GUARDS

A. Furnish and install all safety guards required in order to obtain certificates of inspection from all authorities having jurisdiction.

B. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

3.7 TESTING AND REPAIRING

A. During the progress of each portion of the work or upon its completion, make such tests of this work as herein specified, or as required by the Architect, or by State or Municipal Bureaus having jurisdiction and under their supervision.

B. Provide all apparatus, temporary piping connections, or any other requirements necessary for such tests. Take all due precautions to prevent damage to the building and its contents incurred by such tests as will be required to repair and make good, at no cost to the Owner, any damage so caused. Testing of piping to be insulated shall be done before insulation is applied.

C. Perform any other tests as may be required by the Owner's Representative to indicate the fulfillment of specification requirements.

D. All water piping shall be hydrostatically tested to a pressure of 150 psig or to 1-1/2 times the operating pressure, whichever is the greatest, for six (6) hours.

E. Domestic hot and cold water piping shall be tested at 1.5 times the operating pressure or 150 PSIG, whichever is greater, for six (6) hours. Any leaks developed shall be made tight and the test repeated. Test pressure shall not be applied to specialties, but joint shall be tested for leaks at operating pressure when complete.

F. Waste and vent piping shall be tested at completion of the rough work and before fixtures and traps are connected. Openings, except tops of bends, are to be plugged and the system completely filled with water. System shall stand without leak or loss of water for a period of not less than four (4) hours.

G. Systems shall be tested in portions as required by the construction schedule and the portions being tested shall be effectively isolated and sealed off. When previously tested sections are connected into other sections, tests shall be rerun to include the new connections.

H. Partial systems shall be tested prior to connecting into existing lines.

I. Leaks in screwed joints shall be repaired by tightening the joint until the leak has stopped, or by remaking the joint if tightening fails to stop the leak. Leaks in welded joints shall be repaired by chipping out the weld around the leak and rewelding until it is stopped. Leaks in caulked joints shall be completely stopped by additional caulking of the joint, but, if that fails, the joint shall be re-made. A leak in a compression joint shall be repaired by remaking the joint using a new seal, compression ring, coupling, etc., as required. Leaks in soldered joints shall be repaired by remaking the joint and no soldering or brazing over existing joints will be permitted. Any defective piping shall be replaced.

J. Additional testing shall be as specified in the individual Sections of these Specifications.

K. During testing and cleaning of piping systems, use a fine mesh, 20 mesh or smaller, start-up strainer screen for all strainer pipe sizes. After piping system is cleaned each strainer shall be taken apart, cleaned, and final strainer mesh shall be placed back in strainer for normal operating conditions.

3.8 SEALING PENETRATIONS

A. Seal all pipe and duct penetrations through walls run to structure, ceilings, floors and roofs. Fill the annular space between the insulation on the pipe, or the pipe only where uninsulated, or duct and its sleeve, with neoprene or non-hardening sealant.

B. No pipe or duct shall be allowed to contact its surrounding sleeve or the wall, floor, or ceiling. Effective isolation shall be provided as described in Section 23 05 48 to the end that no vibration or direct noise transmission shall be transmitted. Vibration transmission limits shall be as established in Section 23 05 48. Use special materials as may be required to comply.

C. Firestop pipe and duct floor and wall penetrations as specified in Section 07 84 00 and 23 05 00.

3.9 CONTROLS AND INSTRUMENTATION

A. Section 23 09 00, Controls and Instrumentation, requires thermowells, pete's plugs, and test ports for water temperature and pressure measurement and monitoring purposes for temperature controls and for verification purposes by the Testing, Adjusting and Balancing Firm (TAB), which shall be installed under this section of the specifications. These devices shall be located as verified by the TAB Firm.

B. Temperature control valves shall be furnished as specified in Section 23 09 00, and installed as a part of this Section of the Specifications.

C. Where pressure gauge cocks and pressure/temperature test ports are shown on the Drawings and allow for TAB firm verification additional devices are not required. It is not the intent to provide redundant test ports. However, where sensors are installed in thermowells or other mounting devices separate test ports are required such that sensors do not have to be removed to calibrate or test.

3.10 PAINTING

A. All equipment specified in Division 23 shall be delivered to the site with suitable factory finishes as specified elsewhere herein.

B. Items with factory applied finishes shall be protected during installation and other construction work. Damaged factory applied finishes shall be refinished to match the original finish appearance.

C. Field painting of items specified and installed in Division 23 shall be as specified in Section 09 90 00.

D. All ferrous metals that are not galvanized or made of a corrosion resistant alloy shall be painted. This shall include steel pipe hangars, trapeze supports, pipe stands, all thread hangar rods and other miscellaneous systems.

END OF SECTION

SECTION 23 21 23

CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. Provide water circulating pumps of the type, rotational speed, and arrangement indicated.

B. Each pump shall be rated to deliver the capacity indicated in the tabulation on the Schedule against the head of the system in which it operates.

C. Pumps specified in this section of specifications shall handle chilled, heating or condenser water at no higher than 250 Deg. F. or lower than 10 Deg. F.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the pump manufacturer.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions together with pump curves and head calculations. Head calculations required when piping installation and equipment utilized is significantly different from that shown as determined by the Engineer.

B. Shop Drawings: Submit in accordance with Section 23 05 00.

C. Submittals to include pump and motor efficiencies at full load and at 60 Hertz. For variable speed applications submit on the same at 15 Hertz, 30 Hertz and 45 Hertz.

1.5 PRODUCT HANDLING

A. Cover and protect pumps in transit and at site. Pumps not properly protected and stored and which are damaged or defaced during construction shall be rejected.

B. Cover suction and discharge openings to prevent entrance of dirt and debris until final piping connections are made.

C. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 GENERAL

A. The head capacities indicated in the schedules shown on the drawings are listed for bidding purposes only. Where installation conditions vary significantly enough from the design, as determined by the engineer, the engineer may request that the contractor calculate the actual operating head that will occur at each pump, taking into consideration the actual routing of the various lines, actual submitted pressure drops in heat exchangers and coils, exact lengths of pipe, fittings, etc. Submit these calculations, together with copies of manufacturer's performance curves, as shop drawings on each pump when this applies.

B. Clearly mark the curves for each pump to indicate the diameter of the impeller and the selection point.

C. Motors shall be constant speed, open drip proof type and shall be so sized with relation to the pump impeller that the required brake horsepower shall not exceed the rated motor horsepower at any point on the pump curve. Pumps operating in parallel shall not cavitate when operated alone.

D. Provide each pump with a constant speed motor wound for the electrical characteristics indicated on the Drawings. Motors shall be of the nominal starting torque, low starting current, ball bearing, horizontal, 40 Deg. C. ambient, drip-proof squirrel cage induction type. Motors over 1 H.P. shall be high efficiency type equal to G.E. Energy Saver, Baldor Super "E" or A.O. Smith "E" Plus III. All motors on all pumps shall be of the same manufacture. Refer to Section 23 05 13.

E. Provide each centrifugal pump with an enclosed impeller whose diameter is 90% or less of the maximum impeller which the manufacturer shows in their published curves for that pump.

F. Provide pump casings and mechanical seals suitable for operation under static and dynamic heads for that pump.

G. Pump baseplates shall be constructed of welded structural steel shapes. Provide with raised lip drip pans with threaded drain connection where handling fluids with operating temperatures below 60 Deg. F., such as chilled water. Furnish baseplates with 1/8" thick steel drain pan of sufficient width to extend under, and a minimum of two inches (2) beyond, and catch any drip from connecting flanges. Removable attachments will not be acceptable. Cover pans with rust inhibitive paint.

H. Coupling shall be of the flexible type, capable of withstanding shock, misalignment and end float as manufactured by "Woods".

I. Motor and pump alignment shall be field adjustable, but shall be factory aligned on a common base plate. Supplier shall furnish adequate shims or other alignment accessories necessary to complete field alignment.

J. Coupling Guard: Coupling guard shall be all metal and fastened to baseplate. Guard shall be removable. All exposed moving parts shall be guarded from all sides.

K. Name Plates: Furnish stainless steel data plates permanently secured to the pump.

L. Bearings shall be the heavy duty ball type on both ends of frame and be regreasable.

M. Provide 1/4 inch gauge tappings, fitted with pipe plugs, at each pump flange.

N. Provide minimum 1/2 inch tappings, fitted with pipe plugs, for a casing air vent and drain on the pump volute.

O. Provide extended lubrication lines with universal grease gun stop check fittings for greasing bearings without requiring disassembly of the pump, guards, or other auxiliary devices.

P. All pumps and materials of construction shall be compatible with ethylene glycol.

2.2 END SUCTION PUMPS

A. End suction pumps shall be bronze fitted, base mounted type with flanged inlet and outlet. Flanges shall be rated at 125 PSI. Pumps shall be designed to allow complete removal of the impeller, shaft, and bearings.

B. Each pump and motor shall be mounted on a common baseplate, and shall be connected through a spacer type flexible coupling.

C. The casing bearing bracket, bearing cover and gland shall be of cast iron, ASTM A-48, Class 25A.

D. The shaft shall be of stainless steel construction.

E. The impeller shaft sleeve and casing wearing rings shall all be made of bronze (bronze fitted). Alternately the bearing assembly shaft shall connect to a stainless steel impeller. Impeller shall be both hydraulically and dynamically balanced to ANSI/HI 9.6.4-2009, balance grade G6.3 and secured by a stainless steel locking cap screw or nut.

F. Pump should be designed to allow for true back pull-out allowing access to the pump's working components, without disturbing motor or piping, for ease of maintenance.

G. Seals shall be John Crane, Type 21, or equivalent, mechanical shaft seals.

H. Bearings shall be grease lubricated ball type, selected to the carry radial and thrust loads required based on the scheduled requirements.

I. A bearing assembly shall support the shaft via two heavy-duty regreaseable ball bearings. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end. Pump bearings shall be regreaseable without removal of the bearings from the bearing assembly. Thermal expansion of the shaft toward the impeller shall be prevented via an inboard thrust bearing.

J. The bearing assembly shall have a solid SAE1144 steel shaft. A stainless steel shaft sleeve shall be employed to completely cover the wetted area under the seal.

K. Pumps shall be as manufactured by Aurora, PACO, Bell & Gossett, or TACO.

PART 3 - EXECUTION

3.1 INSTALLATION - BASE MOUNTED PUMPS

A. Prior to performing any installation work inspect pumps to confirm that no damage has occurred from shipping or handling.

B. Compare the motor nameplate electrical information to the power supplied to the pump to confirm the proper power supply is provided. Confirm that the overload relays and fuses or circuit protection rating provided for each pump is proper based on the motor nameplate full load amperage.

C. In mounting pumps verify alignment of driver to pump (horizontal pumps only) and confirm there is no strain on the suction and discharge pipe connections (flanges should meet squarely).

D. Manually turn coupling to insure free rotation of the pump and motor.

E. Insure system is free of foreign matter which could damage pump.

F. Level all frame base mounted pumps by using various thickness steel shims or steel wedges on each side of each mounting bolt set beneath the baseplate on top of the foundation, or inertia base, as per the manufacturer's instructions, without exception.

G. After the baseplate is bolted down, erect forms around the foundation and fill with approved grout. Exercise care to be sure that the entire space under the baseplate is filled with grout. After grout is thoroughly hardened, remove wedges and fill holes with non-shrinking grout. Tighten bolts.

H. Check levelling and alignment and correct, if necessary, with shims under pump or motor feet.

I. Make final connections of piping to pump and support piping independently of the pump. It is imperative that piping be installed in such a manner as not to impose any strain on the pump casing.

J. Connect gauge cocks and gauges to gauge tappings.

K. Connect a gauge cock to the volute air vent connection.

L. Pipe a drain to the drip pan and volute drain and route to the nearest floor drain.

M. Connect power supply and control wiring to disconnect and motor controller.

N. After each unit has been run under actual operating conditions, shut it down and again check its alignment and adjust as necessary.

O. Follow all manufacturer recommended installation instructions to include following and completion of all recommended Pre-start and Post-Start checklists.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other divisions for coordination of work with other portions of Work.

1.2 SYSTEM DESCRIPTION

A. Furnish and install all refrigerant piping of every kind required, specified, or shown on the Drawings for the installation of the work specified in Division 23. The location, direction, and size of the various lines are indicated on the Drawings. Lines for pilot and controls and instrumentation are not shown but shall be installed as required and as specified.

B. Piping systems shall include all appurtenances shown on the drawings and specified herein.

C. Valves or cocks shall be installed to control the flow of refrigerant to each of the various systems, to segregate individual items of equipment, and to permit ease of installation and servicing as directed on the Drawings and specified.

D. The work shall include the furnishing and installing of all supporting structures and members for pipes and equipment.

E. Support devices and members shall include vibration and noise isolating devices and assemblies. Penetrations of walls to structure shall be sealed off to limit noise transmission through sleeves.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed by experienced mechanics certified and trained for the work performed.

1.4 SUBMITTALS

A. Product Data: Submit complete manufacturer's descriptive literature and installation instructions in accordance with Section 01 33 00 for all piping materials to be used for each system, valves and refrigerant specialties as specified herein.

B. Shop Drawings: Submit in accordance with Sections 01 33 00 and 23 05 00. Submit 1/4" = 1'-0" Scale Refrigerant Piping Shop Drawings. These shop drawings may be inclusive with other piping or ductwork shop drawings.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

C. Take special precautions to piping and special internals from construction dirt and debris. If valves are stored on site cover valve openings until just prior to installation but in no case shall valves be unprotected for more than 48 hours.

D. Openings in piping system, coil headers, valves and other heat exchangers shall be covered during the construction period to protect the interior accumulation of dirt and debris in these systems until immediately prior to connection to these components to similarly protected systems.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. In general, the materials indicated herein shall be used in fabricating the refrigerant piping systems. Where special classes of piping are involved and are not indicated, the Contractor shall request instructions as to the class of material involved and the method of fabricating it before ordering the materials.

B. Piping shall be Type L, ACR cleaned and capped, copper. All fittings shall be long radius elbows and standard tees.

C. Only "Silfos" solder joints shall be used for fitting fabrication.

D. Miscellaneous Lines: Pilot, bleed, control, sampling, and equalizing lines, and similar auxiliary lines shall be fabricated of the material used in the system to which they are connected in each case.

E. Miscellaneous Fittings: Provide all reducers, increasers, adapters, bushings, etc., as required to properly inter-connect the various items, to change sizes, etc. Copper and red brass fittings shall be used in copper lines.

F. Fittings for copper tubing shall be Chase Sweat Fittings or Mueller Brass Company's "Streamline" solder fittings. All piping shall be installed according to the manufacturer's instructions. All joints shall be thoroughly cleaned before connecting. Silfos solder shall be used on all refrigerant piping.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all piping and appurtenances to each site. All components shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All items shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces. Rejected items shall be replaced promptly at no cost.

B. During construction, take all steps necessary to protect piping and accessories from damage or vandalism. All damage or vandalism shall be repaired at no cost to the Owner.

3.2 CONDENSING UNIT INSTALLATION

A. Install condensing units level on roof supports where shown with vibration isolation as specified in Section 23 05 48.

B. Route refrigerant piping and make connections to DX coils as recommended by the unit manufacturer and as required to meet the capacity control requirements specified.

C. Furnish and install, if not specified to be factory assembled, all refrigerant piping specialties including, but not limited to, thermal expansion valves, sight glasses, solenoid valves, accumulators, hot gas bypass components, hot gas mufflers, and filter dryers.

D. Charge all refrigerant piping systems and equipment to maintain a fully operating refrigerant charge.

E. Pipe refrigerant relief piping to the outdoors or as otherwise required by the local authorities having jurisdiction and the manufacturer.

3.3 REFRIGERATION PIPING

A. Piping shall be Type "L" copper. ACR cleaned and capped. All fittings shall be cleaned and degreased before use.

B. Flow inert gases such as dry nitrogen through the piping while heating pipe or fittings for joining. Install liquid line drier and sight glass near condensing unit.

C. Leak testings: After the system is installed and before any piping is insulated. The entire refrigeration circuits must be thoroughly leak tested. The following test procedure is recommended:

1. Remove and plug the connection points of any controls or relief valves that could be damaged by test pressure.
2. Connect a cylinder of oil-pumped, dry nitrogen to the front seat port of the compressor discharge valve or at the liquid line charging valve.
3. Test at 150 psig or the leak test pressure specified by local code.
4. Tap each solder connection sufficiently hard to start any leak that might subsequently open from thermal expansion and contraction or vibration.
5. Test all pipe joints for leaks. Brush each connection with a soap solution and watch for bubbles.
6. After leak test, charge enough refrigerant through the liquid line charging valve to raise the system pressure to approximately 10 psig. Remove the refrigerant connection and charge enough nitrogen into the system to raise the test pressure to 150 psig or the local code requirement.
7. Check all parts of the system with a halide torch, or electronic leak detector.

D. Evacuation:

1. Connect the vacuum pump to as many points of the system as possible. Vacuum gauge, a Zimmerli Gauge, or an electronic vacuum gauge, shall be connected to the liquid line charging valve. Open compressor valves. Open the liquid line charging valve.
2. Operate vacuum pump until a vacuum equivalent to 500 microns is registered by the vacuum gauge.
3. When the system has been evacuated, charge enough oil-pumped dry nitrogen into the system to raise the pressure to atmospheric. Re-evacuate the system.
4. After the 500 micron vacuum reading has been re-established, stop the system and allow it to stand under vacuum for a minimum of 12 hours. If the vacuum reading remains unchanged, the system is ready to receive its charge of refrigerant.

E. Charging:

1. Charge the system with new, clean oil and refrigerant of the proper type.
2. Charge until the sight glass is bubble free.
3. Check charge level after system has operated for 24 hours in warm weather. Add oil and refrigerant as needed under these conditions.

END OF SECTION

SECTION 23 25 13

HVAC WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. Install closed chilled and heating water piping systems complete including water distribution lines, expansion tanks, pumps, strainers, air control fittings, flow and pressure regulating valves, relief valves, specialties, insulation, hangers and supports, and appurtenances as shown on the Drawings, as specified herein, and as specified in other Sections of these Specifications.

B. Provide water treatment equipment, chemicals and treatment testing services to treat the closed water piping systems to be cleaned, flushed, and chemically inhibited from corrosion.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a suitable manner by technicians experienced in the work described.

C. All piping cleaning, flushing, and chemical treatment work shall be performed by the piping system installer as specifically directed and supervised by trained and qualified representatives of the firm providing the chemicals and as specified elsewhere herein.

D. Chemical treatment companies providing chemicals, supervision, cleaning, and flushing instructions and chemical testing and adjustment services shall have a minimum of ten (10) years' experience in the local area, located within a 25 mile radius of the project site, in the performance of these services for projects of this size and type. Acceptable firm shall be Chem-Aqua, 2727 Chemsearch Blvd. Irving, TX 75062 (1-866-209-3373).

1.4 SUBMITTALS

A. Product Data: Submit complete manufacturer's descriptive literature for each item specified herein, instructions for water piping flushing and cleaning, and chemical treatment procedures.

B. Include Material Safety Data Sheets on all chemicals to be used.

C. Shop Drawings: Submit in accordance with Section 23 05 00.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 WATER PIPING AND FITTINGS

A. Refer to Section 23 21 13, Hydronic Piping.

B. All chemical treatment, make-up water and expansion piping shall be Type "L" hard drawn copper with wrought fittings using 95-5 solder. Use dielectric unions where connected to dissimilar materials.

C. All piping and isolation valves of every kind required for application of the chemical treatment system shall be furnished and installed by the piping system installer. Refer to Specification Section 23 21 13.

2.2 VERTICAL PRESSURIZED BLADDER TANKS

A. Vertical pressurized bladder type compression tanks for chilled and heating water piping systems shall be furnished and installed in the sizes and where indicated on the Drawings.

B. Tanks shall be made of carbon steel with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 stamp, rated for a minimum 240 Deg. F. design temperature and 125 PSIG design pressure.

C. Bladder shall be made of a heavy duty butyl rubber or full volume flexible elastomer, and shall be replaceable. Bladder material shall be suitable for use in glycol systems.

D. Each tank shall be primed and painted.

E. Provide each tank with floor support ring base, lifting rings, 3/4" drain tapping, air charger valve assembly, and 1", 40 gallon or smaller tanks, or 1-1/2", over 40 gallon tank capacity system connection.

F. Acceptable Manufacturers shall be:

1. Bell and Gossett Type Series "B" Pressurized Vertical Tank,
2. TACO,
3. AMTROL,
4. Or the John Wood Company.

2.3 IN-LINE AIR SEPARATORS

A. In-line type centrifugal air separators shall be furnished for each of the chilled and heating water systems where indicated on the Drawings.

B. Separators shall be line size as a minimum and have 150 pound ANSI Standard flanged connections on the inlet and outlet connections on sizes 2-1/2" and larger, NPT on sizes 2" and smaller. Separators shall be sized as follows:

Pipe Size	Maximum System Flow	B&G Separator Size (Model RL)
2"	45 GPM	2
2-1/2"	72 GPM	2-1/2
3"	130 GPM	3
4"	240 GPM	4
5"	425 GPM	5
6"	680 GPM	6
8"	1250 GPM	8
10"	2100 GPM	10
12"	3000 GPM	12

C. Separators shall have internal stainless steel air collector tubes to direct air to the top of the separator which shall include a NPT vent, air release connection; minimum size of 1-1/4".

D. Provide a NPT blow down connection at the base of each separator to facilitate blow down of debris from within the separator; minimum size of one inch (1").

E. Tanks shall be primed and painted carbon steel same as compression or pressurized bladder tanks.

F. Air separators shall be designed, constructed, and stamped for a minimum 125 PSIG design pressure at 350 Deg.F., design temperature, in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

G. Maximum pressure drop of each separator shall not exceed 2.0 feet of water and the air elimination rate shall be a minimum of 50% on one pass. Submit data to verify compliance with all requirements specified herein.

H. Acceptable Manufacturers shall be:

1. Bell & Gossett Rolairtrol Model RL (No Strainer),
2. TACO,
3. The John Wood Company, or
4. American Wheatley.

2.4 PRESSURE REDUCING VALVES

A. Pressure reducing valves shall be furnished at the make-up water connection to each of the chilled and heating water systems where indicated on the Drawings.

B. Valves shall have an adjustable range of 10 to 25 PSIG. TAB Agency to determine final setting.

C. Valve size shall be a minimum of 3/4" in size.

D. Valves shall have a brass body, low inlet pressure check valve, and integral strainer, which must be removable without system shut down.

E. Acceptable Manufacturers:

1. Bell and Gossett,
2. TACO.
3. American Wheatley.

2.5 PRESSURE RELIEF VALVES

A. Furnish and install individual pressure relief valves at the make-up water connections for each of the chilled and heating water systems where indicated on the Drawings. Combination valves are not acceptable.

B. Valves shall have brass bodies with brass internal parts designed for a maximum operating pressure of 125 PSIG, at a maximum operating temperature of 225 Deg.F.

C. Valves shall be equipped with an EPDM diaphragm to assure positive operation of the valve and to protect non-wetted parts from system fluid.

D. Valves shall be minimum one-half inch (1/2") in size, and have a relief pressure setting of 30 PSIG.

2.6 CHEMICAL SHOT (BYPASS-FILTER) FEEDERS

A. Provide and install one shot type chemical feeders for each of the chilled and heating water systems where indicated on the Drawings.

B. Feeders shall be complete with wide mouth (minimum 3-1/2 inch) secured cap, inlet and outlet taps, and drain tapping, as detailed on the Drawings. Provide a dome shaped top and bottom on all feeders.

C. Shot feeders shall have a minimum five (5) gallon capacity, and be made of cast iron or carbon steel with a 200 PSIG rating at 200 Deg.F. Body shall be painted with an enamel finish.

D. Feeders shall include accommodations for the insertion of filter bags. Provide one (1) initial set of filter bags for each feeder and five (5) additional replacement filter bags per feeder. Filters shall be rated for 25 microns.

E. Feeders and filter bags shall be furnished by the chemical treatment services firm and installed by the piping system installer

F. Acceptable Manufacturers shall be:

1. Garratt-Callahan,
2. Nalco,
3. J. L. Wingert Co.,
4. Neptune.

2.7 AIR VENTS

A. Refer to Section 23 21 13, Hydronic Piping.

B. All air vent purging systems shall be furnished and installed by the piping system installer.

2.8 WATER TREATMENT CHEMICALS

A. Chemical treatment service provider shall furnish one (1) year's supply of the recommended formulas for scale and corrosion protection for all closed system chilled and heating water systems. This shall commence at Substantial Completion, wherein, the project is complete and operational and the Owner has taken over beneficial occupancy or use of the facility. Once the water system is filled, circulated, flushed, and cleaned, additionally provide sufficient chemicals for treatment up to the period of Substantial Completion. This will result in chemical quantities sufficient to treat the system over a 15-18 month period. Include this cost in the Base Bid Amount.

B. All closed chilled and heating water systems shall be chemically cleaned with an alkaline, phosphate formulation, containing dispersants, iron sequestrants, and surface- active materials that remove excess oil, lift solids from metal surfaces and suspend solid particles, and then be thoroughly flushed. After flushing is complete, each closed system shall be treated with a liquid nitrite-borate and/or silicate corrosion inhibitor based formulation, with 600-800 Parts Per Million (PPM) nitrite levels in the chilled water systems and 800-1200 PPM in the heating water systems. For systems with high make-up water flow rates use a molybdate/silicate blend of chemicals and maintain a molybdenum residual range of 48-60 PPM. Once the recommended chemical residual is achieved and documented, provide additional chemicals as required to retreat the system due to water loss on a monthly basis as indicated above (over 15-18 month period).

C. All flushing and cleaning and feeder filter bag replacement work shall be performed by the piping system installer at the direction of the chemical treatment firm.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping system Installer shall lay chilled and heating water piping on an even slope throughout to insure freedom from air locks and traps. Grade each system downward to low points. At each such low point provide a service drain, discharging above a floor drain, where reasonably practical, to permit the

complete drainage of the system. Where it is impractical to route such drain to a floor drain, hub drain, or janitor sink, then provide a valve with hose connection with brass cap and label as "Drain". Such drains, where not routed to a floor or similar drain, shall only be allowed where approved by the Owner's Representative, or where indicated on the Drawings.

B. Automatic air vents shall be provided at all high points in the piping system and where air might collect in closed water systems on a recurring basis. Each automatic vent shall have a valve at its inlet, a valved bypass and discharge line to the nearest floor drain or janitor sink. At all other locations in the piping system where air might collect and need purging on system fill, and where deemed necessary by the Test and Balance Firm, provide a manual valve or pet cock, with removable cap, for manual venting.

C. Piping system Installer shall provide drains from each pump base, air separator, backflow preventors, compression tanks, and other system components with drain connections to the nearest floor drain in each case. Provide any other drain lines indicated on the Drawings in conjunction with the water circulating system or specified elsewhere herein.

D. Piping system Installer shall install valves where required to segregate individual items of equipment or sections of the piping systems as required for project phasing, partial system pressure testing, for temporary bypasses and where indicated on the Drawings.

3.2 FLUSHING, CLEANING, AND CHEMICAL TREATMENT

A. The chilled and heating water systems shall be flushed and pre-cleaned after successful completion of pressure tests and all leaks discovered are repaired.

B. System flushing shall encompass filling the entire system with water, purging all air from the system at high points of the piping and at equipment; and, then, circulating water throughout the entire piping system with all isolation and control valves open to full flow through their respective coils and equipment. Operate multiple system pumps, primary and secondary, as required, to insure water flow throughout all parts of the system. Once water has been circulated for a minimum of 24 hours, the piping system installer shall, starting at the most remote location of the system, quickly open and close coil and equipment drain and strainer blow-down valves, to flush all silt, dirt, sediment, scale, grease, solder, debris, weld slag, and foreign material out of the main and run-out piping, coils, and equipment. Once all such system valves are blown-down, the system water shall be completely drained at each item of equipment and low point drains.

C. Once the system is flushed, refill with fresh water, and purge of air; same as the procedure utilized before initial flushing, as described above. Then, add the specified solution of alkaline, or approved equal, pipe cleaner as provided by the Chemical Treatment Supplier, to be submitted for review for equivalency (to include detailed written cleaning and flushing instructions). This solution shall be circulated in each system for a minimum of 72 hours. During this 72 hour period flush the system by opening and closing each blow down and low point drain valves in the entire system to be cleaned for at least three (3) minutes once every eight (8) hours but not less than eight (8) times total. Following cleaning the system, crack open the blow-down valve at the circulating pump strainer to gradually bleed off the cleaning solution at a rate of approximately 1 gallon per minute which should not exceed the make-up rate while providing make-up water to the system and keeping the system air free. Continue to bleed off the cleaning solution until the discharged water alkalinity, at a remote point in the system, is approximately equal to that of the make-up water. Iron content should be less than 0.1 parts per million (ppm) and total dissolved solids should be within 10% of the make-up water. Testing for these levels shall be performed by the Chemical Treatment Service firm. Additional flushing may be required by the piping system installer should these levels not be accomplished. All strainer screens at pumps and water coils, existing and new, shall be removed and cleaned at completion of this flushing and cleaning process.

D. After system cleaning and flushing is complete, the Chemical Treatment Company shall provide and apply an initial system treatment of corrosion inhibiting chemicals as specified herein, for all closed chilled and

heating water systems, existing and new, consistent with system operating temperature and piping materials installed based on local water analysis.

E. During the construction period after initial system treatment, up until "Substantial Completion" and for the one (1) year warranty period following "Substantial Completion", the Chemical Treatment Company shall provide a continuing water treatment service to include a monthly system analysis and addition of chemicals, as required, to maintain adequate protective treatment concentrations. Log all analysis and chemical additions, during this period.

F. The Chemical Treatment Company shall provide a two (2) hour training session on operation and maintenance to Owner's maintenance personnel beyond normal system start-up.

G. All chilled and heating water system chemicals shall be compatible with the existing system treatment as the new system is an extension of an existing Central Plant System and will be directly connected to the same. Field verify compatibility.

H. Piping System Installer shall physically remove and clean all existing system pump and water coil strainer screens from their bodies at the completion of system flushing and cleaning. Reinstall screens in strainer bodies. Opening and closing of blow-off, drain and blow down connections is not a satisfactory substitute for this requirement. All are required.

END OF SECTION

SECTION 23 30 00

HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. The scope shall include the furnishing and installation of all ductwork as shown on the Drawings; acoustical and thermal linings; flexible ducts and connections; combination smoke and fire dampers, smoke dampers, and fire dampers; duct access doors; intermittent and constant fan powered, single duct, variable, or constant, air volume terminal units and controls; air diffusers, grilles and registers; air volume control devices; hangers and supports; plenums and casings; turning vanes; air filters; installation of temperature control dampers, and other appurtenances necessary for a complete and operational system.

B. All work shall be preceded by taking measurements at the job site, fully coordinating all work with other trades, verifying available spaces for ductwork, and developing Shop Drawings illustrating such.

C. Test all medium and high pressure ductwork systems (constructed to 3.0 inches water gauge and higher) for leaks and repair leaks to limit leakage rate to that as specified.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the quality as specified herein. All work shall comply with the most recent Local Building Code, Mechanical Code, Fire Code, and all other applicable National, State and Local Codes or ordinances.

B. All equipment and materials shall be installed in a workmanlike manner by trained and experienced sheet metal technicians and mechanics as recommended by the manufacturers of the products installed.

C. Where the standards and requirements of this specification exceed those of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) the requirements herein shall govern. As a minimum all ductwork shall be constructed to meet all functional criteria defined in Section 11 of the 2005 SMACNA “HVAC Duct Construction Standards, Metal and Flexible,” Third Edition. However, all ductwork shall comply with all code requirements noted above to include meeting deflection limits established in the local Mechanical code.

D. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job, "Substantial Completion", against noise, chatter, whistling, or vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall either be removed and replaced or reinforced as directed by the Owner's Representative.

E. Air quantities shown on the Drawings, or specified, are based on air at 75 Deg.F. dry bulb, 50 percent relative humidity, and 29.92 inches H.G. barometric pressure.

F. Except where specified otherwise, all sheet metal used shall be constructed from prime galvanized steel sheets or coils up to 60 inches in width. Each sheet shall be stenciled with manufacturer’s name and gauge. Coils of sheet steel shall be stenciled throughout on 10 foot centers (fabricate with stencils to the

outside of the ductwork so they are visible when installed) with manufacturer's name and gauge tolerances in inches:

Gauge No.	Nominal Thickness	Minimum Thickness
26	0.0217	0.0187
24	0.0276	0.0236
22	0.0336	0.0296
20	0.0396	0.0356
18	0.0516	0.0466

G. Contractor shall comply with this specification section in its entirety. If during a field observation, the engineer of record finds changes have been made without prior written approval, the contractor shall make the applicable changes to comply with this specification at the contractor's expense.

H. At the discretion of the Engineer of Record, sheet metal gauges and reinforcing may be randomly checked to verify all duct construction is in compliance with this is specification section.

I. All ductwork and fittings shall have a computer generated label affixed to each section detailing all applicable information including the duct dimensions, gage, reinforcement type/class, and connector type of the systems manufacturer. In addition, galvanizing thickness and country of origin shall be clearly stenciled on each duct section.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions in all items specified herein in accordance with Section 23 05 00.

B. Shop Drawings shall be submitted on all items of sheet metal work specified herein. Shop drawings of ductwork shall be submitted at a minimum scale of 1/4" equal to one foot except that the Congested Areas and all Air Handling Unit Mechanical Rooms shall be submitted at a minimum scale of 1/2" = 1'-0". Provide sections for all Congested Areas and Mechanical Room Plans.

C. Shop Drawings shall include the reflected ceiling plan, screened back, overlaid onto the floor plan indicating the proposed installation of all light fixtures; ductwork layout; duct fittings; duct connection details; offsets; bottom of duct elevations; all sheet metal dimensions (sizes); overall air device sizes, air device neck sizes, air device air flow quantities, and device type; duct pressure classifications; all mechanical piping; any conflicts discovered and unresolved through the use of transitions and offsets in the available space; turning vanes; manual volume dampers; automatic control dampers; smoke and fire dampers; duct access doors; flexible connections; and all mechanical fans and equipment.

D. Sheet metal shop drawings shall be overlaid on piping shop drawings and other shop drawings for other portions of work specified in other sections of these specifications for complete coordination of all work prior to commencing with any installation. These Shop Drawings shall not be prepared directly on the Shop Drawings of other trades; they will be separate from all other shop drawings. Coordination Drawings shall be prepared in accordance with Specification Sections 01 31 00 and 01 33 00.

E. Shop Drawings shall be based on actual field measurements taken at the job site and shall take into consideration all obstacles and be fully coordinated with all piping, conduits, structure, equipment, and general construction features.

F. Shop Drawings shall be generated by a computer aided design and drafting (CADD) system as a CADD drawing. CADD files with Architectural Backgrounds and Mechanical design drawing files will only be

provided when requested, if this privilege has not been previously abused, after a Release of Liability Form has been completed.

G. Include a brochure, with individually assembled cut sheets, and details of all sheet metal fittings, duct construction standards proposed for each system, air volume control devices, and other accessories proposed to be used for job duct construction standards. This shall be done prior to submission or preparation of any sheet metal shop drawings.

H. Should any ductwork installation commence without approved ductwork shop drawings or written approval by the Engineer of Record, the Contractor assumes all liability, to include all costs, in revising any portion of the sheet metal work that is deemed unacceptable by the Owner's Representative to include any conflicts discovered in installation that could have been resolved through the Shop Drawing process.

1.5 GUARANTEE

A. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job, “Substantial Completion”, against noise, chatter, whistling, or vibration, and be free from pulsation under all conditions of operation. This guarantee shall include defects in material, equipment and workmanship.

B. After the system is in operation, should these defects occur, they shall either be removed and replaced or reinforced as directed by the Owner’s Representative. This shall include repair of damages to building materials related to these deficiencies.

1.6 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored, which has been damaged or defaced, or which has gotten wet during storage or construction shall be rejected.

B. Prior to ductwork being installed the roof system, or floor above the ductwork, must be sufficiently installed to protect ductwork from rain water entering ductwork. If the building is not dried-in and walls, windows, etc., are not completed, then cover all openings in ducts with securely fastened heavy duty, minimum three (3) mil thick, plastic to protect from rain damage.

C. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 DUCTWORK

A. General:

1. All ductwork shown on the Drawings, specified or required for the heating, ventilating, and air conditioning systems, shall be constructed and erected in a first-class workmanlike manner by trained and skilled sheet metal workers.
2. All ducts shall be erected in the general locations shown on the Drawings, but must conform to all structural and finish conditions of the building. Before fabricating any ductwork, Contractor shall check the physical conditions of the job site, and shall make all necessary changes in cross sections, offsets, etc., whether they are specifically indicated or not.
3. Before starting shop drawings or fabrication of any ductwork, the Contractor must have an approved reflected ceiling plan with which he can coordinate location of air outlets, lights, tile patterns, etc.
4. The sizes of ducts indicated on the Drawings are the required net internal air stream dimensions, and where ducts are lined, the sheet metal sizes shall be increased three inches (3") in both dimensions to accommodate the linings (1-1/2" thick lining, unless indicated otherwise). Assume all rectangular ducts are lined unless noted otherwise.
5. Ductwork shall be classified, for construction standards, as follows:

a. Medium pressure from variable air volume supply fan (AHU) discharge up to the variable air volume terminals. This ductwork shall be constructed to withstand up to six inch (6") W.G. standards.
b. All other ductwork for constant volume air handling equipment and all constant and variable air volume air handling unit return, relief and outside air intake ductwork are operating at pressures up to two inches (2") W.G., classified as low pressure ductwork, and shall be constructed to two inch (2") W.G. standards.
c. All exhaust ductwork, except grease or other special exhaust systems specified elsewhere herein, all ductwork downstream of variable air volume terminals, all constant volume ductwork (supply and return) served by packaged rooftop units, split direct expansion (supply, return and outside air) A/C units, all ductwork served by fan coil units, and all transfer air ducts shall be constructed to meet one inch (1") W.G. standards.
d. All large centralized exhaust duct systems serving multiple floors and a large number of outlets, more than 10, shall be constructed to meet two inches (2") construction standards. This duct work shall also be pressure tested (positive air pressure) at two inches (2"). Leakage shall be limited to no more than 5% maximum.

6. Except as noted otherwise, ducts, plenums, and casings shall be constructed of new lock forming quality galvanized prime grade steel sheets. The gauges of metal to be used, duct construction details, and the construction and bracing of joints shall be in accordance with the latest edition of the published standards of the ASHRAE Handbook or in accordance with the latest editions of Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) "Duct Construction Standards Manual, Metal and Flexible".
7. Plenum chambers shall be constructed of 18 gauge sheets thoroughly braced with 1-1/2 inch angle irons. All duct panels in rectangular galvanized steel ducts which are 12 inches and wider and which are not lined shall be cross broken.
8. Make square elbows where shown or required, with factory fabricated double thickness turning vanes. Job fabricated vanes will not be acceptable. Except as otherwise specified or indicated on the drawings, make all other changes in direction with rounded elbows having a centerline radius equal to 1-1/2 times the width of the duct in the plane of the bend.
9. Make transformations in duct shape or dimension with gradual slopes on all sides. Normally, make increases in dimension in the direction of air flow, with a maximum slope of one inch (1") in seven inches (7") on any side. Where conditions prevent the normal slope specified above, a maximum slope of one inch (1") in four inches (4") will be allowed only where conditions necessitate.
10. Where a transition must be made with less slope than that noted above, install single thickness guide vanes to insure proper air flow, and to minimize air pressure drop. Transitions that require less slope than that noted above shall be noted on Shop Drawings, and require review and approval by the Engineer prior to installation.
11. Ducts shall be routed in conjunction with all types of pipes, electrical conduits, ceiling hangers, etc., so as to avoid interferences insofar as possible. When duct penetrations are unavoidable, provide streamline-shaped sleeves around such material penetrations, made airtight at duct surfaces, except that such sleeves are not required at tie rods. When the Contractor believes such penetrations are unavoidable, notify the Owner's Representative for approval prior to commencing with such work. Otherwise all such penetrations are not expected to occur and are not allowed. Such penetrations will not be allowed for the convenience of, or lack of coordination by, the Contractor. Where obstructions necessitate, are approved by the Owner's Representative, and are of a size exceeding 10% of the total duct area, the duct shall be transformed to maintain the same original duct area.
12. Where each duct passes through a fan room wall, it shall be wrapped with not less than 1/2" thick closed cell neoprene tightly fitted to the outer surface of the duct all around and sealed. In lieu of this method, completely fill the annular space between the duct and penetration by packing with fibrous insulation and seal the perimeter of the penetration around the duct, on both sides of the penetration, with a flexible non-hardening sealant, to be fire rated when applicable.
13. All outlets or grilles in ceilings shall be supported rigidly from ceiling construction with suitable adapters or bucks installed as necessary and as shown to insure outlets and grilles will be accurately trued up with ceiling.
14. Ductwork shall be fabricated in a manner to prevent the seam or joints being cut for the installation of grilles or diffusers.

15. All sheet metal ductwork shall be securely hung from the building construction. All ducts shall be hung adjacent to the seam in the duct and shall be secured in a suitable manner to both the duct and the building construction. All vertical riser ducts shall be supported at each floor with angle iron secured to the ducts and set on the structure members. These angles shall be the same size as specified for bracing.
16. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time. All panels of uninsulated ducts twelve inches (12") and larger shall be cross broken. In general, sheet metal screws shall not be used in duct construction unless the point of the screw is in the air stream unless specifically indicated otherwise elsewhere herein.
17. Manual dampers shall be installed as shown on the Drawings and as required to afford complete control of the air flow in the various duct systems. In rectangular supply ducts, a splitter damper shall be installed at each point where a branch is taken off and additional volume dampers shall be installed where shown or required to achieve the final air balance. No splitter dampers shall be installed in medium pressure ductwork, unless specifically shown on Drawings.
18. Splitter dampers and volume dampers of the "butterfly" type, installed in rectangular ducts, shall be constructed of 16 gauge galvanized steel riveted or welded to square operating rods. Dampers shall have brass, bronze, or approved plastic bearings. The length of any splitter damper blade shall be 1-1/2 times the width of the smaller split in the duct, but shall be not less than twelve inches (12"). Where splitter dampers exceed 12 inches in height two (2) pull rods shall be used. Splitter dampers 12 inches (12") in height or less shall have one (1) pull rod.
19. Butterfly damper blades in round ducts shall be the full width of the duct in which they are installed. Dampers shall be constructed of a minimum 22 gauge metal. Dampers over twelve inches (12") in diameter shall be constructed of 20 gauge metal, have a continuous rod with end bearings opposite the damper handle, and a quadrant type locking handle.
20. The operating rods of all dampers shall be fitted with Young Regulators and the operating head shall be securely fastened in place so as to be accessible in the finished building unless shown otherwise. Operators shall be attached to duct where regulator occurs above a lay-in ceiling. Use a Ventlok No. 555 locking quadrant on accessible concealed splitter dampers. Where locking quadrants are installed on externally insulated ductwork a hat channel extension shall be used to match the same height as the insulation thickness. Where dampers occur above or behind plaster or other inaccessible ceilings, walls, chases or furrings, provide electronic balancing dampers as specified elsewhere herein. Young Regulator bearings shall also be provided on the opposite end of each operating rod.
21. Behind each ceiling supply outlet, provide and install a turning vane or approved equalizing grid, where noted or scheduled. Where adjustable air pick-ups are indicated at points branch ducts meet trunk ducts, they shall be Titus AG-45 or approved equal with operator adjustable from the duct exterior.
22. Rectangular opposed blade volume dampers shall be as manufactured by American Warming and Ventilating or Ruskin. Blades shall not exceed 48 inches in length or twelve inches (12") in width, and shall be the opposed interlocking blade type. The blades shall be of not less than No. 16 gauge steel supported on one-half inch (1/2") diameter rustproofed axles. Axle bearings shall be the self-lubricating ferrule type.

B. Medium Pressure Ductwork:

1. Rectangular medium pressure ducts shall be constructed of the following gauges:

Largest Dimension of Duct	Gauge of Metal	Maximum Reinforcement Spacing
Up thru 22"	24	4'-0"
23" thru 30"	24	3'-0"
31" thru 36"	24	2'-6"
37" thru 48"	22	2'-6"
49" thru 60"	22	2'-0"
61" thru 72"	20	2'-0"
73" and Up	18	2'-0"

Additional reinforcing shall be per current SMACNA Requirements.

2. The above rectangular ducts shall be constructed in accordance with the requirements of Section 1 of the most recent edition of SMACNA "HVAC Duct Construction Standards Manual, Metal and Flexible". However, the gauge thickness of the ductwork shall meet that as scheduled above. Reinforcing method shall be in accordance with the most current SMACNA standards for the duct classification being constructed taking into account the duct dimensions and gauge thickness; without tie rods through 60 inch sizes and using tie rods 61 inches and over to keep reinforcing angles to 2" maximum.
3. Sealant (MMM EC-800, Hardcast "Iron-Grip 601", Childers CP-146, Foster 32-18, or Polymer Adhesive Sealant Systems, Inc. "Air Seal No. 11" shall be used at all joints on rectangular or round ducts in shop and field fabrication and shall be installed:
   a. In the joint prior to closing to provide a positive seal for slide-on joints
   b. After the joint is closed, for all other joints.
   c. Where "Ductmate" joints are used seal external to joints after the joint is closed as needed to repair all audible leaks and to comply with the leakage test.
   d. All sealants shall be U.L. listed and labeled in accordance with U.L. 181 for duct sealant.
4. Round medium pressure duct construction, gauges and reinforcing shall be in accordance with Section 3 of the most recent edition of SMACNA "HVAC Duct Construction Standards Manual, Metal and Flexible". Straight ducts and fittings shall be of the same manufacturer. Spiral wound ducts shall be used up to 48" in diameter and shall be as manufactured by United Sheet Metal Company or approved equals. Joints shall be joined by approved couplings secured by sheet metal screws and sealant. Ninety degree branch take-offs shall be made with conical tees. Take-off fittings shall be welded to fittings or to the main duct. All welds shall be cleaned and coated with rust-inhibiting paint. Elbows shall be stamped smooth type, or 5 or 3 piece gore type, with either type having a center line radius of 1-1/2 times the duct diameter. Ducts shall be constructed with four-ply reinforcing spiral lock seams. Fittings shall be as manufactured by United Sheet Metal Company, Ward, or approved equals only.
5. Flat oval medium pressure ducts, if used, shall be spiral flat oval or welded flat oval as manufactured by United Sheet Metal Company with gauges and reinforcing as recommended by the manufacturer for medium pressure duty. The ducts may, also, be shop fabricated of completely welded construction of the following gauges with no reinforcing:

Minor Axis of Duct	Gauge of Metal
6" to 10"	24
11" to 16"	22
17" to 24"	20
25" to 36"	18
37" and Up	16

   Fittings shall be as manufactured by United Sheet Metal Company, Ward or approved equals only with requirements, sealing, etc., similar to that specified for round medium pressure ductwork. Fittings shall be matching type manufactured with continuous welds.
6. Medium pressure duct supports:
   a. All horizontal medium pressure rectangular ducts shall have duct hanger requirements as follows:

Maximum Duct Dimension	Minimum Hanger Size	Hanger Size Galv. Steel Strap Width	Maximum Spacing	No. Hangers	Minimum Trapeze Size
Up thru 18"	---	1" x 16 Ga.	10'	2	----
19" to 36"	---	1" x 16 Ga.	10'	2	----
37" to 60"	3/8"	1" x 16 Ga.	8'	2	2 x 2 x 1/4
61" to 120"	3/8"	1-1/2" x 12 Ga.	8'	2	2 x 2 x 1/4
121" to 240"	3/8"	----	4'	2	2-1/2x2-1/2x3/16

b. All horizontal medium pressure round ducts shall have duct hangers spaced 10'-0" maximum, with requirements as follows:

Duct Diameter	Hanger Size	Minimum No. Hangers	Hanger Ring Size
Up to 18"	1" x 16 Ga.	2	1" x 16 Ga.
19" to 36"	1" x 12 Ga.	2	1" x 12 Ga.
37" to 50"	1-1/2" x 12 Ga.	2	1-1/2" x 12 Ga.
51" to 84"	1-1/2" x 12 Ga.	2	Support Bracing Angle

c. Hanger straps on duct widths of 60 inches and under shall lap under the duct a minimum of one inch (1") and have a minimum of one fastening screw on the bottom and two on the side.
d. Hanger straps on ducts with widths over 60 inches shall be bolted to duct reinforcing with 3/8" bolts minimum.
e. Use 3/8" minimum bolt for securing round duct hanger straps to band straps.

7. Where galvanized steel ductwork or joints are welded use “Everdur” welding rods.

C. Low Pressure Ductwork:

1. Rectangular low pressure ducts, systems designated to be operating at up to two (2) inches W.G., shall be constructed of the following medium gauges:

Largest Dimension of Duct	U.S. Gauge of Metal	Maximum Reinforcement Spacing
Up to 26"	26	5'-0"
27" to 42"	24	4'-0"
43" to 48"	22	4'-0"
49" to 60"	20	4'-0"
61" to 84"	18	4'-0"
85" to 96"	18	3'-0"
97" and Over	18	2'-6"

The above rectangular ducts shall be constructed in accordance with Section 1 the latest edition of the "Duct Manual" published by the Sheet Metal and Air Conditioning Contractors National Association. However, the gauge thickness of the ductwork shall meet that as scheduled above.

2. Rectangular low pressure ducts, for systems designated to be operating at up to one (1) inches W.G., shall be constructed of the following medium gauges:

Largest Dimension of Duct	U.S. Gauge of Metal	Maximum Reinforcement Spacing
Up to 36"	26	5'-0"
37" to 48"	24	5'-0"
49" to 60"	24	4'-0"
61" to 72"	22	4'-0"
73" to 84"	20	4'-0"
85" to 96"	18	4'-0"
Over 96"	18	2'-6"

The above rectangular ducts shall be constructed in accordance with Section 1 the latest edition of the "Duct Manual" published by the Sheet Metal and Air Conditioning Contractors National Association. However, the gauge thickness of the ductwork shall meet that as scheduled above.

3. Round low pressure ducts shall be spiral wound as manufactured by United Sheet Metal Company or have grooved seams with flat snaplock longitudinal seams. Spiral seam round duct gauge thicknesses shall be that standard by the manufacturer for the pressure rating of the system. Gauges for snaplock shop fabricated ducts shall be as follows, without exception:

Largest Dimension of Duct	Gauge of Metal	Gauge of Longitudinal Seams and Fittings
Up thru 8" in Diameter	26	26
9" to 14"	26	24
15" to 26"	24	22
27" to 36"	22	20
37" to 50"	20	18
51" to 60"	18	16

Elbows shall have a centerline radius of 1-1/2 times duct diameter or width and for round ducts may be smooth elbows or 5 piece 90 degree elbows and 3 piece 45 degree elbows. Joints of round ducts shall be slip type with a minimum of three (3) sheet metal screws.

4. All low pressure ductwork shall be externally sealed using water based products to include, United McGill Corporation United Duct Sealer, Hardcast "Iron-Grip 601", Childers CP-146, Foster 32-18 or Polymer Adhesive Sealant Systems, Inc. "Air Seal No. 11" duct sealer installed in the joints after closure. All sealants shall be U.L. rated for the application. Seal all external transverse joints, longitudinal seams, and all fitting connections externally to include sealing all duct work accessories, connections to accessories and duct and accessory penetrations (tubes, rods, wires, etc.). Do not seal control rods for actuated dampers and fasteners. Each system shall meet a seal class of “A”.
5. Low Pressure Duct Supports:
   a. All horizontal ducts up to and including 40 inches in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened above to inserts, toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8'-0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.
   b. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one pair of supports 8'-0" on centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

c. Vertical ducts shall be supported where they pass through the floor line with 1-1/2" X 1-1/2" X 1/4" angles for ducts up to 60". Above 60" the angles must be increased in strength and sized on an individual basis considering space requirements.

6. All low pressure ductwork shall be reinforced to maintain a maximum reinforcement spacing as scheduled with the rigidity classification as needed to meet the specification construction standard. Reinforcement spacing shall be reduced as required to meet the construction standard specified using the gauge thickness scheduled.

D. Round Flexible Insulated Ductwork:

1. All round flexible insulated ducts, low and high pressure type, shall be factory fabricated and insulated as manufactured by Thermaflex or Flexmaster USA, Inc. Flexible ducts shall be equal to Thermaflex factory insulated type "M-KC" or Flexmaster “Type 3M”.
2. Flexible duct thermal conductance shall be based on a 75 Deg. F. mean temperature and an aged condition (not out of the box value). Flexible duct insulation shall be a minimum nominal two inches (2.0") in thickness with a minimum 0.75 lb. density. The completed duct assembly shall have a minimum R-value of 6.0. To verify compliance with the Energy Conservation Code in effect, the minimum R-value of 6.0 will need to be documented on the outside of the jacket to allow field verification of compliance with this requirement.
3. The core liner of the flexible duct system shall be a tri-laminate aluminum foil, made with fiberglass and aluminized polyester, or a PVC coated fiberglass cloth. The outer liner shall be a polyester reinforced aluminized foil jacket.
4. Flexible ducts shall be U.L. Listed in accordance with U.L. 181 as a Class I insulated air duct, and shall comply with NFPA Standard 90A and 90B. Flexible ducts shall have a maximum flame spread of 25 and maximum smoke developed rating of 50.
5. Flexible ducts shall be suitable for operating temperatures of -20 up to 250 Deg. F.
6. Flexible ducts shall be suitable for negative pressures of minus one inch W.G. in sizes up to 16" in diameter; and positive pressures up to 10 inches W.G. for sizes up to 16" in diameter. Maximum operating duct velocity rating shall be a minimum of 4,500-5,500 feet per minute.
7. Maximum vapor transmission rating shall be 0.05 Perms as rated in accordance with ASTM-E-96.
8. Unless otherwise noted, the maximum length of flexible duct shall be limited to five feet (5').
9. Securement of flexible ducts to air devices shall consist of sliding the duct onto the air device collar or connector and securing it with plenum rated nylon or teflon panduit band on the inner liner which shall be U.L rated for the application. Fold insulated outer vapor barrier jacket liner over the first band and secure with a second plenum rated panduit band. Make connection vapor tight with a vapor barrier seal using polyester reinforced aluminized duct tape that is two inches (2") wide, wrapped 2 times around the duct, or by the use of a fiberglass mesh wrapped in a similar fashion and coated with a vapor barrier coating, Foster’s Vapor Safe 95-90 or 95-96 mastic or Childers CP-38. Coating must adhere to MIL-PRF-19565C with a permeance rating of less than 0.02 perms per ASTM-E-96, procedure B. No cloth backed duct tape is allowed. All fasteners, adhesives, and duct tape used shall be U.L. rated for the application. All duct tapes used shall be acrylic based.

2.2 ROUND LOW PRESSURE DUCT TAPS

A. Provide round low pressure, systems operating at a maximum of two inches (2” inches) water gauge (W.G.) static pressure, duct taps to serve air devices where shown on the drawings and in accordance with details for these taps

B. Duct taps shall consist of spin-in, or spin on, collar type manufactured fittings specifically made for commercial ductwork systems. Spin-in fittings shall be the conical type as shown and detailed on the

drawings to include integral manual balance damper with locking device. Fittings shall be fabricated using continuous weld longitudinal seams. No riveted construction allowed.

C. All spin-in fittings shall be made with hot dipped, G-60 or G-90, galvanized steel (per ASTM A 653) and be a minimum of 26 gauge in thickness for all sizes from 4” to 12” round. All sizes 14” to 20” round shall be a minimum of 24 gauge in thickness. Thicker gauges shall be provided on larger fittings as required per SMACNA and the Mechanical Code, where required.

D. Provide plain or beaded ends for connection of duct work as required for the application. Crimped ends are not allowed.

E. All ductwork systems are called out elsewhere in these specifications to be externally sealed to limit air leakage. These fittings may either be factory sealed (all seams sealed) or be sealed by the contractor in the field.

F. All spin-in fittings shall also include integral manual balance dampers unless indicated otherwise. Damper options shall be as follows:

1. All manual volume dampers shall be the butterfly type, using a single round damper blade and positive locking regulator damper hardware.
2. Sizes 4”-12” round shall have a reinforced damper axis (not a continuous damper shaft) with ¼” regulator and spring loaded, retractable bearings.
3. Sizes 14” through 20” round shall have a minimum 3/8” continuous damper rod axis with nylon grommets installed at damper sleeve penetrations
4. Provide dampers, which shall include an extended threaded shaft that aligns with a sheet metal stand-off bracket (spot welded to the fitting) with the stand-off distance to be 2” to clear the thickness of any external duct wrap insulation. Coordinate stand-off dimensions with specified duct insulation thickness (only when thicker than 2”). Damper handle and wing nut to be fastened at the outside of the stand-off bracket.
5. Provide premium optional balance dampers to include a 2” stand-off bracket, spot welded to the fitting, to include a 3/8” square shaft extended to the stand-off bracket, with U-bolt, nylon bushings, locking quadrant and handle.

G. Acceptable Manufacturers:

1. Flexmaster or equals by,
2. Crown Company Products,
3. Ductmate,
4. Hercules Industries.

2.3 FIRE, SMOKE, AND COMBINATION SMOKE-FIRE DAMPERS

A. Contractor shall furnish and install fire, smoke, and combination smoke-fire dampers in air passages, openings, and ductwork wherever shown on the Drawings, and as required by the local authorities having jurisdiction. Installations shall be in accordance with all applicable NFPA standards and the SMACNA Duct Manual. All dampers shall carry the U.L. Label and shall be installed such as to conform to conditions under which the U.L. Label was granted. All dampers shall be constructed and tested in accordance with the latest edition of U.L. Safety Standards 555 or 555S, as applicable. Provide sleeves, typically 12" in length minimum, for all dampers as required for the installation conditions encountered.

B. Fire dampers shall be constructed in accordance with the recommendations of the NFPA and shall be of metal gauges required by the class of separation in each case.

1. Interlocking curtain blade type fire dampers carrying the Underwriters' Label will be acceptable, except at locations where an operating type damper is required to meet local requirements, to meet sequence of operations indicated in Temperature Control Specifications, Section 23 0900, or to meet the limited spaces available.

2. Use Style "B" rectangular and style "CR" for round dampers such that blades are out of the air stream.
3. For grille installations at fire rated partitions, use Style "B" thin line fire dampers or Style "G" integral sleeve type for grilles.

C. Smoke dampers shall be designed for vertical or horizontal applications as encountered in accordance with NFPA 90A and meet the latest requirements of UL 555 S. Smoke dampers shall be installed in, or adjacent to, the smoke barrier; but in no case, more than 24 inches from the smoke barrier. Smoke dampers shall be a Ruskin Model SD35, 36, 37, or SDRS25 as applicable for the application. Frames shall be made of 16 gauge single piece galvanized steel hat shaped channel frames. Blades shall be 6" wide galvanized steel and be the triple V-groove or air foil type. Provide stainless steel jamb seals, silicone edge type blade seals where required for the classification, stainless steel sleeve bearings and linkages concealed in the frame. Leakage Class shall be Class 1, 2, or 3, as required, to meet the requirements specified elsewhere herein. Provide compatible electric actuator on all dampers, factory installed.

D. Combination fire-smoke dampers shall be Leakage Class 1 dampers with electric, manually resettable, fuse link operated by 120 volt electric actuator furnished with the damper. Fire-smoke dampers shall be Ruskin FSD-60, or equal, with minimum 16 gauge galvanized steel hat channel shaped frames. Fire-smoke dampers shall be increased in size to maintain a minimum of 90 percent free area of the ductwork size indicated on the Drawings thru each fire-smoke damper. Leakage shall be Class 1, 2, or 3, as required, to meet the requirements specified elsewhere herein. Provide compatible electric actuator on all dampers, factory installed.

E. Insulated all metal access panels, secured with sash locks, shall be installed to service all fire, smoke, and combination smoke-fire dampers. Access panels shall be identified with "FIRE DAMPER", “SMOKE DAMPER”, or "SMOKE-FIRE DAMPER" stenciled thereon in a visible or conspicuous location. Removable flexible duct shall not be permitted as a means of damper access. Access shall be direct and shall not be obstructed by turning vanes or other duct accessories.

F. General Requirements:

1. For “Ductmate” connections at fire, smoke, or combination smoke-fire dampers, do not use screw fasteners.
2. Use four inch (4") draw band connections at round duct fire damper connections.
3. Use blade dampers when the blade width exceeds 12 inches.
4. Install vertical or horizontal mount dampers suitable for the application.
5. Dampers shall be suitable for the maximum air system operating pressures expected to be encountered. Medium pressure ductwork is expected to operate at up to six inches (6") W.G.
6. Use multi-section dampers where damper size openings are larger than single section maximum sizes.
7. Fire, smoke and combination smoke-fire dampers shall be sized to provide for 100 percent of the ductwork size (minimum 95% free area) indicated on the Drawings through each damper.
8. Provide 165 Deg. F. rated fusible links for fire dampers.

G. Acceptable Manufacturers:

1. Ruskin, or approved equals by:
2. Greenheck, or
3. Nailor, or
4. Prefco, or
5. National Controlled Air (N.C.A.), or
6. Air Balance, or
7. Pottoroff.

2.4 FLEXIBLE CONNECTIONS

A. Where ducts connect to fans, including roof exhausters, flexible connectors shall be made that are fire-resistant, (up to 200 Deg. F.), waterproof, mildew-resistant and essentially airtight, and shall weigh approximately thirty ounces (30 oz.) per square yard.

B. There shall be a minimum of one-half inch (1/2") slack in these connections, and a minimum of two and one-half inches (2-1/2") distance between the edges of the ducts for a total of three inches (3"). There shall also be a minimum of one inch (1") of slack for each inch of external static pressure on the fan system for medium pressure systems.

C. Acceptable Manufacturers:

1. Vent Fabrics "Ventglas", or approved equals by:
2. Duro-Dyne.

2.5 ACCESS DOORS

A. Furnish and install hinged, low leakage access doors in ductwork or plenums to provide access to all fire, smoke and combination fire - smoke dampers, mixed air plenums, automatic dampers, coils, filters, and elsewhere as detailed on the Drawings.

B. Where the ducts are insulated, the access doors shall be double skin doors with a minimum one inch (1") of insulation in the door. The insulation shall have a minimum R-value of 5.0. Increase the thickness of the insulation as needed to comply. Where the access door is installed in non-insulated ductwork the access door shall be unlined sheet metal of the same gauge thickness as the duct.

C. In no case shall access doors be smaller than eight (8") by eight inches (8"). Access doors shall be sized to permit testing or servicing of duct mounted components, such as, for coil cleaning, installation of control devices, resetting of fusible links, filter replacement, etc., as applicable and suitable for the application.

D. Where duct access doors are above a suspended, normally non-readily accessible ceiling, such as plaster, gypsum board or spline type ceilings, Contractor, under this Section of Specifications, shall be responsible for the proper location, and furnishing of, ceiling access doors, or panels, to make duct access doors easily accessed through the ceiling system. Ceiling access doors, or panels, shall be rated, where applicable, to match the fire rating of the ceiling system penetrated. Ceiling access doors, or panels, shall be installed under other Sections of these Specifications. Ceiling access doors, or panels, shall be centered directly beneath duct access doors or immediately adjacent thereto when duct access is through the side of the duct.

E. In rectangular grease exhaust ducts, install access doors every twenty feet (20') maximum, center to center, and at all 90 degree elbows, when the total developed length exceeds forty feet (40'). Install access doors at every other floor level for vertical grease exhaust duct risers.

F. All access doors shall be fully double gasketed, door to frame and frame to duct, and include a sash type or compression latches for sizes under eighteen inches (18") by eighteen inches (18"). Use one (1) sash type latch per twelve inches (12") of height or width. Access doors 18" x 18" and larger shall have quarter turn handle latches. Provide one handle per 24" section, height or width, of door. As an example, provide two (2) handle type latches for a 48" tall access door.

G. Provide a minimum of two (2) heavy loose pin hinges for each access door unless indicated otherwise herein. Piano style hinges will be an allowed substitute.

H. Where the installation conditions prohibit suitable access with hinged access doors, then non-hinged access doors may be used in conjunction with a corrosion resistant cable or chain, of suitable length, attached to the access door and duct.

I. For duct systems constructed to 2 inches W.G standards, or less, provide standard access doors meeting all requirements specified herein, which have a tested air leakage rating of less than 4.0 CFM at a test pressure of 2 inches W.G., and as manufactured by:

1. Ventlok with hinges and No. 90 or No. 99 latches (less than 18" x 18"), or No. 100 or No. 140 latches (18" x 18" and larger), as applicable, or approved equals by:
2. Ductmate, or
3. Duro Dyne DDIAD-0806, or
4. NCA Manufacturing ADH-T-1, or
5. Pottorff HAD or CAD, or
6. Nailor 08SH with HP Seal, or 0890, or
7. Cesco Products HDG, or
8. Ward Sandwich Style Access Doors, DSA or DDA, for round ductwork.

J. For duct systems constructed over 2 inches W.G., up to 6 inches W.G. standards, provide high pressure low leakage access doors meeting all requirements specified herein, which have a tested air leakage rating of less than 1.0 CFM at a test pressure of 6.0 Inches W.G. and as manufactured by:

1. Ventlok similar to that noted above, or their Twist-In Door (insulated), or approved equals by:
2. Ductmate “Sandwich” (Rectangular ducts), or Ductmate “Metu” (Round ducts), or
3. Ward Duct Connector Industries Type ‘F’ (Rectangular ducts) or Type ‘R’ (Round Ducts), or
4. Nailor 0820-1 or 0895, or
5. Pottoroff OAD.

2.6 TURNING VANES

A. Turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct.

B. Turning vane front and back panels shall be securely locked together with adequate crimping to prevent twisting of vane. Vanes shall be capable of withstanding 250 pounds of tensile load when secured according to the manufacturer’s instructions.

C. Rails for mounting vanes shall have self-locking, friction fit tabs designed to facilitate proper alignment of vanes. Tab spacing shall be as specified in Figure 4-3 of the 2005 SMACNA Manual, “HVAC Duct Construction Standards, Metal & Flexible”, Third Edition standard. Rail systems with non-compliant tab spacing shall not be accepted.

D. Acoustical Turning Vanes shall be used in applications that require quiet operating systems. Mounting rails shall have friction insert tabs that align the vanes automatically. These shall only be required where designated on the Drawings.

E. Approved Manufacturers:

1. Ductmate Industries PRO-Rail Turning Vane or approved equals.

2.7 DUCT LINER

A. Where indicated on the Drawings or specified herein, all rectangular ducts; except science lab fume hood exhaust ducts; shall be lined with Fiberglass mat faced duct liner in the thicknesses, type, and locations as indicated elsewhere herein and as indicated on the Drawings.

B. Science Lab fume hood exhaust air ducts and other industrial type exhaust air ducts shall not be lined.

C. Line 15'-0" on each side of each in-line relief air fan with one and one half inch (1-½") thick liner.

D. All transfer air duct sleeves and sound boots, shall be lined with one inch (1") thick duct liner. Also line the science laboratory general exhaust air ductwork with this same liner up until the point that it joins ductwork carrying fume exhaust from fume hoods.

E. The liner insulation system shall generally be one and one-half inches (1.5") in thickness on all conditioned air, heated or cooled, as well as outside air intake ducts, and mixed air plenums to obtain a minimum R-value of 6.0 thereon. Line all of these systems within 10'-0" of each air handling unit. Mixed air plenums shall be lined with a minimum of 1-1/2" thick liner unless indicated otherwise on the drawings. Similarly line the first 10'-0" downstream of each variable air volume terminal unit, single duct and fan powered terminal units.

F. The liner insulation system for all sound sensitive areas shall be two inches (2") in thickness for conditioned supply air as well as return air ductwork, only where indicated on the Drawings.

G. All ductwork systems are required to meet the most recent version of the International Energy Conservation Code.

H. All duct liners shall comply with NFPA 90A and 90B and ASTM C 1071, Type I, for ducts and Type II for plenums (rigid liner). Liner shall consist of flexible, matt faced insulation made of inorganic glass fibers bonded by a thermosetting resin with an encapsulant edge coating, and shall be a rotary style duct liner product with a water repellant ingredient on the mat face to help keep moisture from penetrating the air stream surface. Other technical requirements shall include:

1. Be suitable for temperatures up to 250 Deg. F. per ASTM C 411.
2. Be suitable for air velocities up to 6,000 FPM per ASTM C 1071 for Type I products and 5000 FPM for Type II products.
3. Water vapor sorption shall be less than 3% by weight per ASTM C 1104.
4. Air stream surface mat facing shall be tested with an EPA registered anti-microbial agent to aid in the prevention of fungal and bacterial growth. Mat face, as treated, shall not support the growth of mold, fungi, or bacteria per ASTM C 1338, ASTM G 21 and ASTM G 22.
5. Does not exceed a Flame Spread of 25 and Smoke Developed and Fuel Contributed of 50 per ASTM E 84, NFPA 225, and UL 723.
6. Conductance of 0.24 (R-value of 4.2) for a 1.5 PCF or 2.0 PCF duct liner at a 75 Deg. F. mean temperature per ASTM C177 for a one inch (1") thick product.
7. Greenguard Compliant (Greenguard Environmental Institute).
8. Noise Reduction Coefficient (NRC) of 0.70 or higher for a one inch (1") thick product and 0.80 for a two inch (2") thick product per ASTM C 423, type A mounting.

I. All duct liners shall be able to be cleaned in accordance with the North American Insulation Manufacturers Association (NAIMA) "Cleaning Fibrous Glass Insulated Air Duct Systems Recommended Practices".

J. Liner shall be applied to the inside of rectangular ducts and plenums with fire-resistant adhesive, Fosters 85-60, 85-65, or Childers CP-127, Hardcast "Seal-Tack" or Ward "Premium Duct Liner Adhesive", or approved equals only, complying with ASTM C 916, completely coating the clean sheet metal. All uncut joints in the insulation shall be "buttered" and firmly butted tightly to the adjoining uncut liner using the same fire resistant adhesive.

K. Where a cut is made in the insulation for duct taps, etc., the "raw" edge shall be accurately and evenly cut and shall be thoroughly coated with a water based fire resistant adhesive. Where tears in the insulation occur coat such with the same adhesive (duct liner protective coating). Adhesives shall be Design Polymerics Duct liner Protective Coating (2510/2515/2540/2545), Ductmate Super Liner Seal (SLS), or approved equals only.

L. On ducts over twenty-four inches (24") in width or depth, the liner shall further be secured with mechanical fasteners. Fasteners shall be Graham or Gemco weld pins. "Stick Clips", "Sheet Metal Clips", or other fasteners secured to the ducts by adhesive are not allowed. Fasteners shall be placed on a maximum spacing of eighteen inches (18") and shall be pointed up with fire-resistant adhesive. Fasteners shall not compress the insulation more than 1/8".

M. Liner shall be accurately cut with all cut ends thoroughly coated with an approved liner edge coating adhesive so that when the duct section is installed, the liner shall make a firmly butted and tightly sealed joint. Provide metal nosings securely installed over transversely oriented liner edges facing the air stream at all fan discharges, at access doors, and at any interval of lined duct preceded by unlined duct. This

adhesive type shall be Duro Dyne “Dyn-O-Coat”, or equal. This shall be an aerosol which is quick drying, flexible and tack free. Treat all exposed edges, butt seams, and inadvertent tears.

N. Where rectangular ducts are lined and adjoins externally insulated rectangular ducts, the two insulations shall be overlapped not less than twenty-four inches (24").

O. Dimensions given on the Drawings are inside air stream, free area, dimensions only and sheet metal sizes shall be increased in size to maintain these free area dimensions when liner is installed.

P. All exposed ductwork shall be internally lined unless specifically indicated otherwise.

Q. Refer to Section 23 07 00, Insulation, for further related requirements.

R. Acceptable liner manufacturer shall be:

1. Certainteed, Tough Gard R with enhanced surface.
2. Knauf, Rotary Duct Liner E-M with Hydroshield.
3. Owens Corning, Quiet R Acoustic Duct Liner, Type 150 or equivalent Duct Liner Board.
4. Johns Manville, Linacoustic RC or R-300.

2.8 GRILLES, REGISTERS, AND DIFFUSERS

A. Grilles, registers, ceiling outlets, diffusers and other air devices shall be as scheduled on the Drawings and shall be suitable for the intended use.

B. Provide air devices with sponge rubber or soft felt gaskets at flanges where the devices mate up to a ceiling or wall surface.

C. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level or criteria, face velocity, throw, drop, pressure drop, air diffusion, etc., before the submittal is made. Selections shall meet the manufacturers' own published data for the above performance criteria. The throw shall be such that the terminal velocity will be not more than 50 FPM or less than 25 FPM at the point of penetrating the occupancy zone. The occupancy zone is defined as six feet (6') above the finished floor and six inches (6"), or farther, from the walls.

D. Noise levels shall not exceed those published in current ASHRAE Standards and Guidelines for the type of space being served (N.C. level) or that scheduled.

E. Locations of outlets on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures, structure and Architectural Reflected Ceiling Plan (RCP). Air devices shall have margins, frames, and sizes to be compatible with the ceiling and wall systems installed. All color and finishes are subject to final approval by the Architect.

F. Where called for on the schedule, grilles, registers, ceiling outlets, diffusers and other air devices shall be provided with deflecting devices and manual dampers.

G. Where indicated on the Drawings, provide a fire rated blanket on the back side of steel ceiling mounted air devices (supply, return, exhaust, etc.).

H. Where indicated on the Drawings, provide an insulation blanket on the back side (all surface area) of ceiling mounted supply air devices to prevent condensation.

I. All air devices shall be the standard product of the manufacturer, subject to review by the Architect. Acceptable manufacturers are:

1. Titus, or approved equals only by:
2. Krueger.
3. Nailor.
4. Metal-Aire.

5. Carnes.
6. Price Industries.

2.9 KITCHEN HOOD EXHAUST DUCTS

A. The kitchen hood exhaust duct system shall be constructed of 16 gauge carbon steel with liquid tight continuous external welds at all seams and joints in accordance with NFPA 96 and local codes.

B. The ductwork shall be installed with access doors at every 20 feet on center, as applicable, and at each elbow to facilitate cleaning, as required by code, and as required to provide access to fire protection devices in the duct. Access doors shall be grease tight construction with suitable hinges and latches.

C. The duct shall slope 1/4 inch per foot from the discharge point toward the hood.

D. All changes in direction shall be made with 1-1/2 times the duct width to centerline radius elbows; no turning vanes or mitered fittings will be allowed.

E. The ductwork shall be enclosed in a fire-rated duct enclosure, refer to Architectural Drawings, from the point of ceiling penetration to the outside air. The duct enclosure shall be sealed around the duct at the point of penetration to the outside air. The duct enclosure shall be sealed around the duct at the point of penetration and vented to the exterior through weather-protected openings.

F. Make rigid connections to the hood and fans, transitioning as required, for connection at each piece of equipment. Seal duct connections to fan and hood.

G. Do not internally line grease exhaust ductwork.

2.10 DISHWASHER EXHAUST DUCT SYSTEM

A. Dishwasher exhaust ducts shall be constructed of 18-8 stainless steel, Type 304, and be installed in accordance with all local codes.

B. Exhaust ducts shall be minimum 20 gauge thick (minimum 0.035 inches thick), when concealed above ceilings, with continuous liquid-tight welded and treated joints and seams, using stainless steel rods, on the interior or exterior of the duct surface. Use 18 gauge thick stainless steel with welded finished joints where exposed. Welded joints shall be at the top edges of the ductwork.

C. Ducts shall slope 1/4" inch per foot toward the grille, hood or an approved reservoir.

D. All changes in direction shall be made with 1-1/2 times the duct width to centerline radius elbows; no turning vanes or mitered fittings will be allowed.

E. Provide duct access doors every twenty feet (20'), if required, and at each change in direction for duct cleaning purposes. Access doors shall be of water tight construction with suitable hinges and latches.

F. Do not internally line dishwasher exhaust ductwork.

2.11 FAN POWERED VARIABLE AIR VOLUME TERMINALS

A. Furnish and install fan powered variable air volume terminals of the sizes and types as indicated to meet scheduled capacities.

B. All air terminals shall have their performance certified in accordance with the most recent American Refrigeration Institute (ARI) Standard 880 Certification Program and carry the ARI seal.

C. Terminal unit casings shall be constructed of not less than 22 gauge galvanized steel for units with casings 36", or smaller, in any dimension; and 20 gauge for units larger than 36" in any dimension. Casings shall be galvanized steel, mechanically assembled and sealed to form an air tight casing with a maximum air leakage of 2% at 6 inches (6") W.G. internal pressure, tested per ASHRAE Standard 130.

Spot welded casings are not acceptable. Interior walls of the casing shall be lined with 0.75 inch thick dual-density fiberglass with four (4) p.c.f. skin density rated for a maximum airflow velocity of 4500 fpm. Insulation and adhesives shall meet all requirements of UL 181 and NFPA 90-A. Raw edges exposed to the airstream shall be coated and sealed. Access openings shall be provided and be large enough for removal of the unit fan assembly or the largest single item contained therein from the bottom side of the terminal. Configuration of fan assembly and primary air volume valve assembly shall be such that the terminal unit shall have one discharge opening for all functions, no multiple openings, unless no stratification of the cooling or heating air streams occurs at the discharge.

D. Primary air control valve assemblies shall be pressure independent and shall reset to any airflow between zero and the maximum catalogued air volume. The primary air valve damper blade shall be heavy gauge galvanized steel with a continuous peripheral gasket. Air valve assembly body shall be not less than 22 gauge in thickness. The air volume control damper blade shall be bolted or welded to a continuous shaft which rotates in self-lubricating bearings. Damper blade shall close against a closed-cell gasket seat, and be factory preloaded to insure a tight seal. Blade shall not deflect at inlet pressures up to 6 inches W.G. In full closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalog rating of 3" W.G. inlet static pressure, when tested in accordance with ASHRAE Standard 130. Blade shall fail to the normally open position.

E. The airflow sensor shall be of cross configuration located in the inlet of the assembly. The sensor shall have twelve total pressure-sensing ports and a center averaging chamber designed to accurately average the flow across the inlet of the assembly. Sensor shall provide accuracy to within 5% with a 90 degree sheet metal elbow located directly at the inlet of the assembly. The air flow sensor shall amplify the sensed air flow signal.

F. The fan assembly shall be not less than 18 gauge galvanized steel. Fan assembly shall include an adjustable cut-off and field adjustable discharge/backdraft damper suitable for balancing discharge air flow, forward curved centrifugal type fan wheel and three-speed permanent split capacitor motor. Provide a factory installed three-speed switch to allow switching of fan speeds in the field without reworking the motor wiring. Provide a rheostat (electronic fan speed controller, or SCR). Rheostat shall be a long life dependable controller made of the highest quality and shall be matched with the motor. Provide non-adjustable factory set, minimum speed stop on speed controller to prevent motor damage due to low voltage conditions. Motor shall remain three-speed. Motor shall have thermal and overcurrent protection factory installed. Factory installed fused disconnect shall be installed. The fan assembly shall be internally suspended and isolated from the unit casing on rubber-in-shear isolators. Speed selection shall be manually set by multi-speed switch, without requiring field wiring modification. Provide all air flow proving switches and fan relays with terminal as required for the application all terminal units shall be either ETL or UL listed as a completed assembly.

G. Single speed motors shall be considered when the motor and silicon controlled rectifier (SCR) speed controller have been selected to be compatible, matched, at all points of recommended operation with the SCR being included in the units' agency listing. The performance data included in the ARI Certifications shall include the SCR as an integral component. Include with submittal "Letter of Conformance" from manufacturer on their letterhead indicating compliance with this requirement; otherwise, a three-speed motor will be required.

H. Pressure differential reset controller shall maintain set point (CFM) within 5%, regardless of system pressure change (pressure independent). The reset controller shall constantly monitor air flow system static and total pressure. Airflow settings shall be field adjustable from a minimum of 0 CFM to a maximum compatible with box size. Flow curve for field balancing shall be permanently affixed to terminal casing. Averaging velocity sensors shall be utilized. Single point differentials shall not be acceptable. Terminal unit manufacturer shall include the cost of factory mounting and wiring the DDC controller and air damper actuator supplied by the Controls Manufacturer as specified under Section 23 09 00, Controls and Instrumentation, in factory furnished metal control enclosure. Unit manufacturers

shall furnish and install a 24 volt controls transformer, supplied by the fan power source, to serve the controller and actuator per the requirements outlined by the manufacturer of these components.

I. Induction port sound baffle/attenuator, shall be provided with all terminals and be insulated the same as unit casing and constructed of 22 gauge galvanized steel. Baffle shall be an integral part of the terminal and be certified to produce a minimum 5 dB reduction in radiated noise level. Maximum N.C. level of terminal unit under any operating condition shall not exceed 35. NC value shall be calculated using ARI Standard 885-98, Appendix E attenuation factors, unless otherwise specified herein. Baffle shall be factory assembled and be designed such that filters are located on the outside inlet portion of the baffle to allow filter replacement without disassembly or removal of any other component. [For units with hot water coils the coil piping shall be fully to the exterior of the baffle such that the baffle could be removed without requiring disassembly of the piping].

J. Where indicated, fan terminals shall include a two (2) row hot water coil where indicated on the Drawings. Coil shall be attached to the induction port for parallel fan configurations, and to the terminal discharge for series fan configurations, in a manner so as to allow removal for maintenance or cleaning. Coil shall be constructed of pure aluminum fins of 0.005" to 0.010" thickness, with die-formed spacers. Fins shall be mechanically fixed to 0.063" copper tubes for maximum heat transfer. Coils shall be tested at 300 psig and be ARI rated.

K. Furnish filter frames with disposable 1" thick filter cartridge. Filter frame shall be sized to provide for a maximum of 350 feet per minute velocity thru the filters. Provide multiple filters as required to meet this requirement. Filter frames shall be constructed of “U” shaped galvanized steel pieces, with a top and bottom rail as a minimum, fastened to the plenum air inlet location. Provide stops to hold filters in this frame. Final filters shall be MERV 11 pleated 1” type.

L. Reference "Temperature Controls" Section 23 09 00 for sequence of controls operation.

M. Terminals shall be suitable for steel angle trapeze support from beneath unit while allowing suitable access for maintenance. Provide factory furnished clip-on angle brackets for support of terminal from structure above by the use of 3/8 inch all thread rods.

N. Furnish detailed submittals to include a line-by-line itemized listing of all terminals shown on the Drawings with plan design cooling, minimum cooling and fan CFM capacities. Include fan curves and related balancing data to illustrate the ability of the fan to be adjusted to meet various air system pressure drops. Furnish wiring diagrams, heating coil performance data, and cut sheets for each size and type of terminal to be furnished.

O. Acceptable Manufacturers:

1. Envirotech VVF-II, or approved equals only by:
2. Titus.
3. Trane.
4. Price Industries.
5. Nailor.
6. MetalAire.

2.12 SINGLE DUCT VARIABLE AND CONSTANT AIR VOLUME TERMINALS

A. Provide single duct variable and constant air volume terminal boxes of the sizes and types as indicated on the Drawings to meet scheduled capacities.

B. Air terminals shall be certified under the American Refrigeration Institute (ARI) Standard 880 Certification Program and carry the ARI seal.

C. Terminal casings shall be constructed of not less than 24 gauge galvanized steel, mechanically assembled and sealed to form an air-tight casing. Air leakage shall be limited to a maximum 2% at six inches (6") W.G. internal system static pressure, tested in accordance with ASHRAE Standard 130. Spot

welded casings are not acceptable. Internal lining shall be provided and shall consist of a minimum 1/2 inch dual density fiberglass with 4 p.c.f. skin density rated for a maximum air velocity of 4500 FPM. Insulation shall meet all requirements of UL 181 and NFPA 90-A. Raw edges of insulation shall be coated and sealed.

D. Pressure differential reset controller shall maintain set point (air flow rates in CFM) within 5% regardless of system pressure changes (pressure independent). The re-set controllers shall constantly monitor air flow system static and total pressure. Minimum (adjustable to zero flow) and maximum air flow (CFM) settings shall be field adjustable. Flow curve for field balancing shall be permanently affixed to terminal casing. Averaging velocity sensors shall be utilized. Single point differential sensors shall not be acceptable. Terminal unit manufacturer shall include the cost of factory mounting and wiring the DDC controller and electric air damper actuator supplied by the Control Systems Manufacturer as specified under Section 23 09 00, Controls and Instrumentation, in factory furnished metal control enclosure. Unit manufacturers shall furnish and install a 24 volt controls transformer to serve the controller and actuator per the requirements outlined by the manufacturer of these components.

E. The primary air valve assemblies shall be pressure independent and shall reset to any airflow between zero and the maximum catalogued air volume. The air valve assembly shall be a minimum of 22 gauge G60 galvanized steel The primary air valve damper shall be heavy gauge metal, with peripheral gasket, and solid steel shaft, pivoted in self-lubricating bearings. In the full closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalog rating at 3" W.G. inlet static pressure, when tested in accordance with ASHRAE Standard 130. The airflow sensor shall be of cross configuration located at the inlet of the assembly. The sensor shall have twelve total pressure-sensing ports and a center averaging chamber designed to accurately average the flow across the inlet of the assembly. Sensor shall provide accuracy within 5% with a 90 degree sheet metal elbow located directly at the inlet of the assembly. The airflow sensor shall amplify the sensed air flow signal.

F. Reference "Temperature Controls" Section of Specifications, Section 23 09 00 for sequence of operation and related requirements.

G. Acceptable terminal manufacturers:

1. Envirotech SD, or approved equals only by:
2. Titus.
3. Trane.
4. Price Industries.
5. Nailor.
6. MetalAire.

2.13 OUTSIDE AIR INTAKE AND RELIEF AIR/EXHAUST OUTLET HOODS

A. Furnish and install outside air intakes and relief air outlets of sizes as scheduled or shown on the plans. Face velocities shall generally not exceed 1000 FPM for outlets and 500 FPM for intakes. Air pressure drop shall not exceed 0.15 In. W.G. in all cases.

B. Hoods shall be of all welded and lock formed galvanized steel or all aluminum construction. Furnish with aluminum bird screen and a removable sloping top insulated on the bottom with mastic insulation and coated with an anti-condensate coating. Hoods shall be hinged for access to ductwork and shall be fastened closed.

C. Furnish minimum 12 inch high roof curbs for outlets and 16 inch high curbs for intakes made of 16 gauge spot welded galvanized steel and insulated on the inside of the curb with 2" thick fiberglass board for thermal insulation and to prevent condensation. Provide wood nailer for fastening.

D. Provide a 2" wide neoprene rubber pad continuous around the curb for mounting of intake to provide a weather seal and to damper wind born vibration. Secure hoods with stainless steel screws 8" on centers.

E. Acceptable hood manufacturers:

1. Penn "Airette", or approved equals by:
2. Greenheck.
3. Loren Cook.
4. Acme.

2.14 LINED SPIRAL DUCT

A. Lined spiral duct shall be United McGill Acoustic-K27 duct or equivalent. Utilize duct-duct slip joint connector, conical reducing tees, and 5 gore elbows (60 Deg. and 90 Deg.) for offsets and end runs.

B. Inner duct liner shall be perforated 28 gauge galvanized steel with 1.5" thick [1.0" thick allowed if ductwork is exposed in a conditioned space], 1.5 pound density, fiberglass insulation sandwiched between it and the outer duct. The outer duct shall be spiral seam construction, and be a minimum of 24 gauge galvanized steel.

C. In lieu of the perforated steel and factory installed insulation liner, an extra heavy density liner, field installed, may be used as an equivalent to the 1.5" thick Johns Manville Spiracoustic Plus. This system shall have a minimum R-value of 5.0 at 75 Deg. F Mean Temperature, with a noise reduction coefficient of 0.80. The airstream surface shall be coated and be suitable for mechanical cleaning.

D. Externally seal all duct connections, transverse and longitudinal, with a sealant being listed and labeled in accordance the requirements of U.L. 181A or U.L. 181B such as Foster 32-19 duct sealant.

2.15 AIR FILTERS

A. Provide appropriately sized and number of air filters for each piece of individual air handling equipment to include, but not be limited to, the following:

1. Air Handling Units.
2. Fan Coil Units.
3. Fan Powered Terminal Units, series and parallel fan arrangement type.
4. Roof-top AC Units.
5. Elsewhere as required to protect air type heat exchangers, such as warm air furnaces, or coil surfaces, such as duct mounted direct expansion coils.

B. High performance, extended area, 2” or 4" nominal depth, mini-pleated, disposable filters shall be provided where scheduled or as indicated in other Sections of these Specifications. These filters shall have the following characteristics:

1. Filter media shall be assembled in compact secure enclosures.
2. Filer media shall consist of 100% melt-blown, polypropylene joined with fire retardant bonding agents. Polypropylene separators shall be bonded to the media that are designed to maintain pleat configuration and stability. Media shall have a progressive denier of fibers with coarse fibers on the air entering side and finer fibers on the air exiting side.
3. The media pack, or filter frame, shall be completely enclosed and bonded around the perimeter to a high wet-strength “beverage” board enclosing frame. This frame shall include diagonal support members on the air entering and air exiting sides to maintain pleat spacing and to provide adequate support to maintain the filter pack shape under operating conditions.
4. Filters shall be capable of withstanding 10 inches W.G. without distortion of the media pack or filter frame.
5. Sizes shall be standard sizes that are readily available by multiple sources and be as indicated elsewhere herein.
6. These filters shall have an efficiency of 80-85% when tested in accordance with the most recent version of ASHRAE Standard 52.1. The filters shall have a MERV rating of 13 when tested in accordance with the latest version of ASHRAE Standard 52.2. Initial pressure drop of clean filters at 500 FPM shall not exceed 0.45” W.G.
7. Provide product test data and related details in accordance with ASHRAE Standards 52.1 and 52.2 for each efficiency specified.
8. Acceptable Manufacturers:

    a. Camfil Farr, Inc., Model “AP-Thirteen”, or approved equals by:

b. Environmental Filter Corporation.
c. Eco-Air.

C. Medium efficiency air filters shall generally be one (1”) or two inches (2") thick, unless indicated otherwise and shall be the pleated media, disposable type, listed by Underwriters Laboratories as Class 2, with the following features:

1. Air filters shall be rated in accordance with the most recent version of ASHRAE Standards 52.1 and 52.2, test methods as indicated herein, and shall conform to Section 7.4 of ARI Standard 850.
2. Filter media enclosing frame shall be constructed of rigid, heavy duty, high wet-strength resistant, “beverage” board with diagonal support members on the air entering and air exiting sides. Expanded diamond grid media support, integral with frame, shall be chemically bonded to filter media at each pleat, to insure pleat spacing and stability. Pleated media shall be bonded to the inside of the frame to eliminate air bypass.
3. Filter media shall be high performance, non-woven, reinforced cotton-poly, synthetic blend fabric formed in a V-shape.
4. Filters shall have the following performance data:

THICKNESS	SQUARE FEET MEDIA AREA TO ONE SQUARE FOOT FACE AREA	MINIMUM PLEATS PER LINEAL FOOT	INITIAL AIR RESISTANCE (INCHES W.G.)	RESISTANCE BASED ON AIR FLOW OF
One Inch (1")	2.4	16	0.25 (350 FPM)	1400 CFM
Two Inch (2")	4.3	15	0.28 (500 FPM)	1500 CFM
Four Inch (4")	6.9	11	0.27 (500 FPM)	1500 CFM

5. Filters shall be suitable for operation with varying velocities of up to 500 feet per minute (FPM) for 2" and 4" filters and 350 FPM for 1" filters.
6. Filters shall have a minimum efficiency of 20% for particles in the 0.3 to 1.0 micro range, 65% for particles in the 1.0 to 3.0 range, and 85% for particles in the 3.0 to 10.0 micron range as tested in accordance with ASHRAE Standard 52.1. Filters shall also have a MERV rating of 11 as tested in accordance with ASHRAE Standard 52.2.
7. Refer to equipment schedules for more specific filter MERV rating requirements.
8. Acceptable Manufacturers:

a. Camfil Farr, Inc., Model AP-Eleven, or approved equals by:
b. Environmental Filter Corporation.
c. Eco-Air.

D. All filters shall be standard sizes that are readily and locally available, in stock, through multiple over the counter sources without requiring special order. Standard acceptable sizes shall be 16" x 20" and 16" x 25".

2.16 MIXED AIR BLENDERS

A. Furnish and install air blenders in the mixed air plenums of the air handling units of the size and type as shown on the Drawings.

B. Air blenders shall be rated for the total air handling unit air flow rate scheduled with the maximum air pressure drop of 0.12 inches W.G. Use multiple blenders where needed to fit the limited spaces available.

C. Air blenders shall be factory built and tested.

D. Air blenders shall be installed in strict accordance with the manufacturer's recommendations, and as shown on the Drawings.

E. Units shall be static devices, completely fixed, with no moving parts.

F. Air blenders shall be fabricated of minimum 0.08 inch thick aluminum and be all welded construction.

G. The maximum standard deviation of the mixed, discharge airstream, resulting from the mixing of two airstreams, shall be 6.0 Deg. F.

H. Provide holding frame and safeing as specified elsewhere herein. Blank off all air flow around blender to be in accordance with SMACNA blank-off standards.

I. Acceptable Manufacturers:

1. Blender Products, Inc., or approved equal by:
2. Kees, Inc.

2.17 ADHESIVES AND SEALANTS

A. All adhesives and sealants used on this project must have a Volatile Organic Compound (VOC) content less than that listed in the current South Coast Air Quality Management District (SCAQMD) Rule 1168, and all sealants and fillers must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

B. All adhesives and sealants shall meet the most current Leadership in Energy and Environmental Design (LEED™) requirements.

2.18 FIBERGLASS DUCTBOARD

A. Fiberglass duct board of any type is not allowed on this project without exception.

2.19 ELECTRONIC BALANCING DAMPERS

A. Where balance dampers are to be located above a hard ceiling, or in any inaccessible location, the contractor shall use electronic balancing dampers controlled with an Electronic Balancing Damper Positioner (EBDP) which opens and closes the damper and provides a visual indication of the damper position with a LCD meter.

B. Each Remote Damper Assembly shall consist of a commercial quality damper actuated by a 12V DC motor with position feedback, a plenum rated cable with RJ-25 connectors on each end, termination options to control the damper from either a plenum, wall or ceiling location, and a hand held damper positioner that provides DC voltage to open and close the damper while displaying the damper position with the LCD position indicator meter.

C. Each damper shall be either a round, rectangular, or High Efficiency Takeoff type damper, as applicable to the installation. Round dampers shall consist of a 20 gauge galvanized steel shell and blade with ½" plated steel damper shafts, and 12V DC Motor with position feedback. Rectangular dampers shall consist of a 20 gauge aluminum frame and blade, stainless steel slide, 18 gauge galvanized steel mounting plate for slip in installation, and 12V DC motor with position feedback. High efficiency takeoff dampers shall consist of a galvanized steel takeoff with 20 gauge blade and ½" steel shafts, and 12V DC motor with position feedback. Dampers shall include oil impregnated bronze bushings. Damper actuators shall use less than 0.5 watts of power (20 mA), have a torque capability of 16 inch-pounds (maximum), and rotate the damper from 0 - 90 degrees in 12 seconds of less. Feedback shall occur via a proportional voltage signal. Provide low leakage damper blade seals.

D. Electric Cables shall be plenum rated cable, have modular connectors and be available in lengths up to 1,000 feet. Length of individual cables shall be field verified to insure no field splicing of cables is required. One modular connector shall be attached to each motor and the other end shall include a RJ-25 modular connector that would be installed inside a plenum or at a wall or ceiling receptacle, to be coordinated with the architectural drawings (acceptable locations). Ceiling connections shall be the

concealed type similar to Young Regulator Company (YRC) TP -301. Wall connections shall be the suitable for 1- 6 ports and be similar to YRC TP-Wall.

E. The Positioner (EBDP) shall be used to control all remote electronic balance dampers installed on site by use of ceiling or wall mounted receptacles, a plenum connection or a combination of these options. The Positioner shall be self-contained and be a hand held device. Each positioner shall be provided with a high capacity long life lithium battery which shall be easily replaced in the field. Provide one (1) Positioner for each site or building to include one (1) spare battery for each positioner furnished. Positioner shall use a modular RJ-25 connector that plugs into the modular connector served by the 12V DC motor. The positioner battery shall drive the damper motor open and closed. The positioner shall also house the LCD display that provides precise damper position indication throughout the range of movement via a proportional voltage feedback signal from the motor.

F. Acceptable Manufacturers:

1. Young Regulator.
2. Greenheck.
3. Metropolitan Air Technology (MAT).
4. Or other approved equals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all ductwork and equipment as indicated on the Drawings in full accordance with these specifications including foundations, hangers, supports, etc.

B. Seal all ductwork as specified, pressure test and repair leaks.

C. Install all air intake, relief and exhaust air hoods on continuous neoprene strips set level on top of wood nailers of the specified roof curbs. Hoods shall be secured at 8" O.C. to the curbs with corrosion resistant screws if not secured by other fasteners as specified. Flash and counterflash to prevent water leakage through the overall roofing system.

D. Install all duct mounted components such as heating coils, electric or water type, sound attenuators, air terminals, etc. in accordance with the manufacturer’s recommendations.

E. Should defects or installation deficiencies become apparent, or are observed, after the systems have been in operation, the deficient components shall be removed and replaced or reinforced as directed by the Owner's Representative.

3.2 CLEANING OF DUCT SYSTEMS

A. Before the grilles or diffusers are installed, all fans and air conditioning units shall be operated and all debris and foreign matter shall be removed from the ducts.

B. The air conditioning units shall be thoroughly cleaned, and the drain pans shall be thoroughly cleaned and flushed out with a hose; the filters shall be thoroughly cleaned and the grilles shall then be installed.

C. Insure all duct openings are capped and sealed during construction when additions are not being made.

3.3 STATIC PRESSURE DUCT TESTING - MEDIUM PRESSURE SYSTEMS

A. All medium pressure (constructed and rated at 3.0 inches water column or higher) ducts, new and existing where re-used, shall be pressure tested by the Contractor, witnessed by the Testing, Adjusting, and Balancing (TAB) firm, according to the most current version of the SMACNA HVAC Air Duct Leakage Test Manual test procedures where the Construction Class is designated to be 3.0" W.G. and higher.

B. Design pressure for testing medium pressure ductwork shall be six inches (6") of water gauge, unless indicated otherwise herein.

C. Test ductwork from fan connection up to and including the hard sheet metal tap just prior to the final connection at each terminal unit. Test in sections as required based on the Leakage Test Kit utilized. Use a United McGill Corporation LTK-S (small) or LTK-L (large) Leakage Test Kit with accessories as required to perform the test. This shall include a calibrated orifice tube with certified calibration chart, fan, and two U-tube manometers with connecting tubing.

D. Tests shall be performed as soon as possible after the first section of ductwork to be tested is installed to evaluate the quality of the installation early in the process to allow corrective actions to be taken before the entire installation is completed.

E. Cap all open ends of duct systems to be tested for testing purposes. Make temporary openings for test equipment as required. Patch these to match new installation conditions when tests are complete and accepted per criteria stated herein. Generally, follow United McGill's procedures as published in their document titled "System Pressure Testing for Leaks", or the SMACNA Manual referred to herein.

F. All ducts shall have been sealed as specified, during installation, and shall be sealed as a Seal Class "A" per SMACNA.

G. Leaks that whistle or are excessive, as determined by the Owner's Representative, shall be repaired and the test repeated until such are eliminated.

H. Maximum leakage rate of each system shall not exceed 2% of the design operating air volume; or, whichever is most restrictive, be equal to 6.0, or less, in accordance with the following equation (from International Energy Conservation Code):

1. Leakage Rate 6.0 = $FxP^{0.65}$
2. F = Measured Leakage Rate in CFM per 100 square feet of duct surface.
3. P = Test Static Pressure, In. W.G.

I. Provide duct leakage test report summary for submission and review by the Owner's Representative. At least one test, preferably the first to occur, shall be witnessed by the Testing, Adjusting, and Balancing (TAB) Agent. Test Report Summaries shall include the following:

1. Cut sheets on test equipment used along with calibration sheet for orifice tubes used.
2. Drawing or diagram depicting portion of duct system tested. Indicate square footage of ductwork in test section.
3. Indicate test pressure used in test, versus, construction class of duct installed.
4. Note allowed leakage in CFM for test section.
5. Indicate actual leakage recorded during the test.

J. All tests shall be repeated until the sections tested all pass the test per the criteria stated herein.

3.4 STATIC PRESSURE DUCT TESTING - LOW PRESSURE SYSTEMS

A. All designated low pressure duct systems, only systems with continuous duct lengths of 50 feet or longer, and all fume exhaust ductwork, shall be pressure tested by the Contractor, witnessed by the Testing, Adjusting, and Balancing (TAB) firm, according to the most current version of the SMACNA HVAC Air Duct Leakage Test Manual test procedures.

B. Design pressure for testing low pressure duct work shall be two inches (2") of water gauge, unless indicated otherwise herein. All pressure tests shall be conducted under a positive pressure, even for systems intended to operate at negative air pressures such as exhaust systems.

C. Test duct work from fan connection up to and including the hard sheet metal tap just prior to the final connection at each air device. Test in sections as required based on the Leakage Test Kit utilized. Use a United McGill Corporation LTK-S (small) or LTK-L (large) Leakage Test Kit with accessories as required

to perform the test. This shall include a calibrated orifice tube with certified calibration chart, fan, and two U-tube manometers with connecting tubing.

D. Tests shall be performed as soon as possible after the first section of duct work to be tested is installed to evaluate the quality of the installation early in the process to allow corrective actions to be taken before the entire installation is completed.

E. Cap all open ends of duct systems to be tested for testing purposes. Make temporary openings for test equipment as required. Patch these to match new installation conditions when tests are complete and accepted per criteria stated herein. Generally, follow United McGill's procedures as published in their document titled "System Pressure Testing for Leaks", or the SMACNA Manual referred to herein.

F. All ducts shall have been sealed as specified, during installation, and shall be sealed as a Seal Class "A" per SMACNA.

G. Leaks that whistle or are excessive, as determined by the Owner's Representative, shall be repaired and the test repeated until such are eliminated.

H. Maximum leakage rate of each system shall not exceed 5% of the design operating air volume; or, whichever is most restrictive, be equal to 6.0, or less, in accordance with the following equation (from International Energy Conservation Code):

Leakage Rate $\leq 6.0 = FxP^{0.65}$
F = Measured Leakage Rate in CFM per 100 square feet of duct surface.
P = Test Static Pressure, In. W.G.

I. Provide duct leakage test report summary for submission and review by the Owner's Representative. At least one test, preferably the first to occur, shall be witnessed by the Testing, Adjusting, and Balancing (TAB) Agent. Test Report Summaries shall include the following:

1. Cut sheets on test equipment used along with calibration sheet for orifice tubes used.
2. Drawing or diagram depicting portion of duct system tested. Indicate square footage of duct work in test section.
3. Indicate test pressure used in test, versus, construction class of duct installed.
4. Note allowed leakage in CFM for test section.
5. Indicate actual leakage recorded during the test.
6. All tests shall be repeated until the sections tested all pass the test per the criteria stated herein.

3.5 KITCHEN HOOD EXHAUST DUCTS

A. Prior to the concealment of any portion of the grease duct system, an air leakage test shall be performed as noted in Paragraph 3.4.

B. Prior to the concealment of any portion of the grease duct system a light test shall also be performed on all field or shop welded or brazed joints in the system to include hood-to-duct connections. The light test shall involve passing a lamp with a power rating of no less than 100 watts through the entire length of duct work. The lamp shall be exposed and fully open to allow light to emit equally in all directions. Systems may be tested in Sections, if necessary, provided that all joints are tested. Provide duct light test report summary (suitable video tape confirmation is acceptable) for submission and review by Owners Representative. Testing shall comply with Section 5.06.3.2.5 of the 2009 International Mechanical Code (IMC) or later.

3.6 AUTOMATIC CONTROL DAMPERS

A. Refer to Section 23 09 00, Controls and Instrumentation.

B. Install all temperature control modulating dampers under this section of the specifications, furnished in Section 23 09 00.

3.7 FILTERS

A. No air moving equipment may be operated at any time without filters being fully installed in equipment.

B. Provide a minimum of three (3) spare sets of two inch (2") thick, medium efficiency, pleated media filters for all air handling and fan coil units, as well as for filter return air grilles where scheduled, in addition to manufacturer furnished filters specified elsewhere herein. Where other sections of these specifications require one inch (1") or four inch (4") thick filters, or other types of filters, provide spare sets of matching thickness and type.

C. Additionally replace filters during construction as directed by the Owner's Representative.

D. Install one (1) new complete set of filters, as directed by the Test and Balance (TAB) Firm, just prior to performance of TAB work.

E. Install one (1) new set of filters at "Substantial Completion" of the project.

F. Where the minimum number of filter sets are not used for the aforementioned purposes, provide the left over filters to the Owner for maintenance stock.

G. Document, in writing, when each filter change-out occurs.

END OF SECTION

SECTION 23 34 00

EXHAUST AND SUPPLY AIR FANS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION

A. Provide exhaust fans of the type, rotational speed, and arrangement indicated.

B. Each fan shall be rated to deliver the capacity indicated in the tabulation on the Schedule against the external resistance of the system in which it operates.

C. Provide high efficiency motors as specified in Section 23 05 13 for motors one (1) horsepower and larger.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed by experienced mechanics and as recommended by the fan manufacturer.

C. All fans shall bare the AMCA and U.L. Labels. Capacity ratings shall be based on tests performed in accordance with the latest version of AMCA Standard 210 and Publication 211.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions together with fan curves.

B. Shop Drawings: Submit in accordance with Section 23 05 00.

C. When equipment, other than specified, is proposed, the Contractor shall be completely responsible for electrical revisions necessitated. Submit listing of electrical feeder and conduit sizes, breaker sizes, and motor starter sizes for each item of equipment where motor sizes are required to be larger than specified to meet scheduled capacities.

1.5 PRODUCT HANDLING

A. Cover and protect fans in transit and at site. Fans not properly protected and stored and which are damaged or defaced during construction shall be rejected. Cover all openings to prevent entrance of dirt and debris until final connections are made.

B. Storage and protection of materials shall be in accordance with Section 23 00 00.

PART 2 - PRODUCTS

2.1 FANS - POWER ROOF VENTILATORS (PRV-DOME AND UPBLAST TYPE)

A. Fans shall be direct or belt-drive, down blast or up blast type, units as indicated, positively ventilated, permanently lubricated, have sealed motors and fan shafts with ball bearings. Belt drive units shall be complete with cast iron adjustable sheaves.

B. Provide centrifugal all aluminum fans with static and dynamic balance and with capacities as scheduled on drawings, all tested, approved, rated and bearing the AMCA Seal of Approval.

C. Provide all aluminum weatherproof housing, venturi throat inlet, bird screen and disconnect. Provide for concealed wiring such that power wiring does not penetrate roof but runs within curb.

D. Curbs shall be minimum 14" high, made of galvanized steel and be insulated with minimum 1-1/2", 1-1/2 PCF density insulation, have continuous perimeter treated wood nailer and be furnished with a neoprene isolation strip to be placed on the top of the nailer. Provide sloped bottom of curbs to match roof pitch to allow for fans to be installed level.

E. Furnish automatic backdraft dampers for all fans, unless indicated otherwise. Only up blast grease exhaust models will not have backdraft dampers.

F. Provide grease container, hinged curb-base for inspection and cleaning of duct, and minimum 16" high vented curb extension to sit on top of base curb on all upblast grease hood exhaust fans. Minimum distance required from top of finished roof to grease exhaust discharge elevation shall be 40”. Where the 16” extension does not achieve this elevation requirement increase the base curb height as required, in two inch (2”) increments, to achieve this requirement.

G. For up blast dishwasher hood fans provide epoxy coating on all materials of construction exposed to the air stream.

H. For kiln exhaust systems the exhaust fan and drive assembly shall be rated for a minimum of 300 Deg. F. The Flo-Aire Model DU25H (Verify size on each project per fan schedule) has generally been pre-approved for typical kiln exhaust systems that are coupled with vent-a-kiln exhaust hoods. Submittal data shall confirm compliance with this requirement.

I. Provide SCR fan speed controller on direct drive motors with minimum stop for motor protection to be factory mounted on unit to be used for final air balance purposes.

J. Acceptable manufacturers:

1. Loren Cook.
2. Greenheck.
3. ACME.
4. Penn.
5. Flo-Aire.
6. Twin City Fans and Blowers.

2.2 CEILING CABINET EXHAUST FAN

A. Provide in-line type ceiling cabinet exhaust fans with the capacities and characteristics scheduled.

B. Fans shall be AMCA certified and bear the label thereof.

C. Casing shall be made of galvanized steel and acoustically insulated for quiet operation. Housing shall be installed to provide for accessibility and removal of motor and blower without removing housing from the system.

D. Motors shall be permanently lubricated and have accessible internal wiring. Provide permanent split capacitor (PSC) motors. Provide external toggle disconnect switch with each fan.

E. Provide noiseless backdraft damper integral with unit.

F. Provide SCR fan speed controller with minimum stop for motor protection to be factory mounted on unit to be used for final air balance purposes.

G. Provide flat roof caps of the sizes indicated for each fan. Each cap shall be a minimum of eight inches (8") in diameter and shall be the curb mounted type to ensure proper flashing. Curbs shall be minimum twelve inches (12") high, made of galvanized steel and be insulated with minimum 1-1/2", 1-1/2 PCF density insulation, have continuous perimeter treated wood nailer and be furnished with a neoprene isolation strip to be placed on the top of the nailer. Provide sloped bottom of curbs to match roof pitch to allow for roof caps to be installed level.

H. Acceptable manufacturers:

1. Loren Cook Gemini.
2. ACME Masterette.
3. Greenheck SP/CSP.
4. Penn Zephyr.
5. FloAire.
6. Twin City Fans and Blowers, T or TL series

2.3 CENTRIFUGAL INLINE FANS

A. Provide centrifugal in-line fans where indicated to meet the capacity requirements scheduled.

B. In-line belt, or direct driven, centrifugal fans shall consist of a square steel housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

C. Housing: Heavy gauge steel with primer and final enamel coats of paint, or galvanized steel, inlet and outlet flanges, support bracket adaptable to floor, side wall, or ceiling mounting, and access panels.

D. Direct-Drive Units: Motor encased in housing out of air stream, factory-wired to disconnect located on outside of fan housing.

E. Belt-Drive Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and heavy duty lubricated and permanently sealed, pillow block type fan bearings. Motor and drives shall be out of air stream. Drives to be sized for 150% of motor horsepower.

F. Wheel: Aluminum, centrifugal blower, with non-overloading blades and tapered inlet. Wheel shall be statically and dynamically balanced.

G. Accessories: The following accessories are required as indicated:

1. Companion Flanges: For inlet and outlet duct connections.
2. Fan Guards: Expanded metal in removable frame.
3. Speed Control: For direct drive units, provide a variable speed switch with on-off control and speed control for 100 to 50 percent of fan air delivery.
4. Disconnect switch unit mounted.

H. Fan wheel, bearings, shaft, and drive components shall be serviced or removed without disturbing ductwork connections. Access doors shall be hinged or fully removable.

I. Blower assembly shall bear the AMCA seal of approval for both air and sound.

J. Acceptable manufacturers:

1. Loren Cook.
2. Acme.
3. Greenheck.
4. FloAire.
5. Twin City Fans and Blowers.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to the site as indicated in Division 1.

B. Contractor to perform installation and start-up to include installation of all accessories as required to make a complete and operating system.

C. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost to the Owner.

3.2 EXHAUST FANS - INSTALLATION

A. Install fans level on housekeeping pads, suspended from structure, or as indicated, and provide vibration isolation internally or externally as required, as specified herein, or as specified in other sections of these specifications.

B. Suspended fans shall be set level with all thread rod from structure above.

C. For fans installed in wall sleeves secure fan to wall sleeve with non-ferrous corrosion resistant fasteners and seal watertight.

D. Field install motor and other accessories not factory installed.

E. Verify operation of automatic motorized and backdraft dampers.

F. Adjust fan drives and replace sheaves as required to obtain scheduled capacities as directed by the Test and Balance firm.

3.3 ROOF MOUNT CURBED EXHAUST FANS

A. Install all roof mounted exhaust fans on the factory fabricated and insulated roof curbs. Flash and counterflash to prevent leakage.

B. Mount fan base on neoprene strips on curb tops.

C. Secure fan base to curb with non-ferrous fasteners.

D. Field install motor and other accessories not factory installed.

E. Verify operation of backdraft and motorized dampers.

F. Adjust fan drives or replace sheaves as directed by the Test and Balance Firm to obtain scheduled capacities to and as required to meet field conditions.

3.4 CLEAN-UP

A. Clean all fans and components after installation is complete.

B. Vacuum clean all debris from inside scrolls, on fan wheels and at drives.

END OF SECTION

SECTION 23 43 23

POLAR IONIZATION AIR PURIFICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 – General Requirements and reference documents.

B. Comply with all other Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.2 SYSTEM DESCRIPTION OF WORK

A. Provide cold plasma ion generating air purification systems intended for use as part of another manufacturer’s air handling unit or mounted in the ductwork as shown on the plans, details and equipment schedules.

B. Each cold plasma generator shall be “Needlepoint” type. Tube type generators shall not be used.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed by experienced mechanics and as recommended by the manufacturer.

C. All cold plasma arrays shall be UL 86-2007 tested and U.L. listed. The technology shall have been tested to DO-160 by an independent lab and successfully passed all requirements for shock, vibration, EMF and line noise. Manufacturers not tested to DO-160 shall not be acceptable.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for ion generators including:

1. Schedule of plasma generators indicating unit designation, number of each type required for each unit/application.
2. Data sheet for each type of plasma generator, and accessory furnished; indicating construction, sizes, and mounting details.
3. Performance data for each type of plasma device furnished.
4. Product drawings detailing all physical, electrical and control requirements.
5. Statement on the manufacturer’s letterhead stating that the technology contains no titanium dioxide (Ti02).

B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.

B. Store in original cartons and protect from weather and construction work traffic.

C. Store indoors and in accordance with the manufacturers’ recommendation for storage.

1.6 WARRANTY

A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of eighteen months after shipment or twelve months from owner acceptance, whichever is longer.

PART 2 - PRODUCTS

2.1 BI-POLAR IONIZATION GENERATORS

A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit scheduled.

B. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.

C. The Bi-polar Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Capable of reducing static space charges.
4. Effectively reducing space particulates.
5. When mounted to the air entering side of a cooling coil, minimizing the pathogen and mold growth on the cooling coil.
6. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:

a. MRSA > 96% in 30 minutes or less
b. E.coli > 99% in 15 minutes or less
c. TB > 69% in 60 minutes or less
d. C. diff > 86% in 30 minutes or less
e. Noro Virus > 93.5% in 30 minutes or less
f. SARS-CoV-2 (COVID-19) > 99.4% in 30 minutes or less

D. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable. Ionizers with positive and negative output (DC type) shall not be acceptable. All ionizers provided shall be AC type ionizers with one electrode pulsing between positive and negative.

1. Air exchange rates may vary through the full operating range of a constant Volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
2. Velocity Profile: The air purification device shall not have maximum velocity profile.

E. Thermal Conditions: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 99%, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty. Generators shall be capable of operation from -20 Deg F to 140 Deg F.

F. Equipment Requirements:

1. Electrode Specifications (Bi-polar Ionization):

a. The plasma electrode shall require no more than one inch in the direction of airflow for mounting. All hardware required for mounting shall be provided by the air purification manufacturer except self-tapping screws for housing mounting.

b. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion. Plasma generators with recessed needles shall not be acceptable. Bar style bipolar ionization shall not be acceptable.
c. Electrodes shall be wire such that they are energized when the unit fan is energized and de-energized with the unit fan. This shall be through the unit control board or separate EMS relay, as needed.
d. Electrode shall be carbon resin type construction.
e. The ionization output shall be as follows, when measured 1 inch form the cold plasma needles:

1) 0 – 6,000 CFM sizes, a minimum of 140 million ions/cm3
2) 6,000 – 10,000 CFM sizes, a minimum of 200 million ions/cm3

G. Mounting Requirements:

1. General:

a. Ionizers shall be mounted perpendicular to the airflow such that the airflow is across the generator.
b. Units mounted external to the ductwork or air handling equipment but internal to the building shall be housed in a minimum Plastic ABS UL 94 enclosure with all ion generating components in the airstream.
c. Units mounted internal to the ductwork or air handling equipment shall be mounted in a minimum plastic ABS 94VO enclosure. Enclosure shall be mounted to fan scroll or ductwork when less than 3,200 CFM in size and in the fan section when over 3,200 CFM in size. Where mounted internal to the ductwork, any duct penetrations from mounting screws shall be sealed air tight with duct sealant as specified in Section 23 30 00.
d. No units shall be mounted external to the building envelope or roof mounted air handling equipment enclosures.

2. Air Handler Mounted Units:

a. Where so indicated on the plans and/or schedules Ionizers shall be supplied and installed. The mechanical contractor shall mount the Ionizers in the location specified on the drawings and wire to a 24 VAC Transformer power supply from a control panel. A 24VAC circuit shall be provided to the plasma generator module. Each plasma generator shall be designed with a casing, liquid tight flexible conduit and a quick connector.
b. Generators shall generally be mounted in the fan section of the respective unit and be mounted between the cooling coil and fan for draw through unit configurations.
c. Generators shall generally be mounted in the discharge plenum of the respective unit for blow through multi-zone type units upstream of both the cooling and heating coils/decks.
d. Generators shall generally be mounted in the fan section of the respective unit for blow-through units, upstream of the cooling and heating coil sections.

3. Roof Top Unit Mounted Units:

a. Where so indicated on the plans and/or schedules Ionizers shall be supplied and installed. The mechanical contractor shall mount the Ionizers in the location specified on the drawings and wire to a 24 VAC Transformer power supply from a control panel. A 24VAC circuit shall be provided to the plasma generator module. Each plasma generator shall be designed with a casing, liquid tight flexible conduit and a quick connector.
b. For units with airflow less than 3,000 CFM, the ionizer shall be mounted to the fan scroll in the fan section, where not mounted in the ductwork.
c. For units with airflow greater than 3,000 CFM, the ionizer shall be mounted in the fan section of the unit, where not mounted in the ductwork.

4. Duct Mounted Units:

    a. Where so indicated on the plans and/or schedules Ionizers shall be supplied and installed. The mechanical contractor shall mount the Ionizers in the location specified on the drawings and wire to a 24 VAC Transformer power supply from a control panel. A 24VAC circuit shall be provided to the plasma generator module. Each plasma generator shall be designed with a casing, liquid tight flexible conduit and a quick connector.
    b. Where Ionizer(s) are to be installed within the ductwork, there shall be an access door added to the ductwork provided for servicing the generator equipment.
    c. Where multiple Generators are to be installed within the same ductwork, they are to be installed around the perimeter of the ductwork and not directly down stream of each other.

H. Generator Requirements:

1. Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.
2. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator, power supply, and housing. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by 24VAC with the use of an existing controls transformer. Ionization systems requiring isolation transformers or separate 120 VAC or greater power shall not be acceptable.
3. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced (AC Ionizers only are acceptable). Imbalanced levels shall not be acceptable.
4. Ionization output from each electrode shall be the minimum amount noted above when tested at 1" from the ionization generator.
5. Ozone Generation:

    a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation.

6. Units shall have no greater than 0.05 in. w.g. pressure drop across the module when tested at 5,000 FPM.

I. Electrical Requirements:

1. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 24VAC. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.
2. Contractor shall provide power to generators and where generators are installed internal to ductwork or unit provide grommet for wiring back to unit controller.
3. Power consumption shall be no greater than 12 VA at 24 VAC per generator module.

J. Control Requirements:

1. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.
2. The ionization system shall be provided with dry contact status to the building Energy Management System (EMS).
3. The installing contractor shall mount and wire the Plasma device within the mechanical equipment specified or as shown on the plans. The contractor shall follow all manufacturer IOM instructions during installation.
4. A plastic enclosure with Ionization LED On/Off Indicator Light and alarm dry contacts for building EMS shall be provided to house the power supply.

K. Acceptable Manufacturers:

1. Phenomenal Aire.
2. Global Plasma Solutions.
3. Plasma Air.

2.2 HAND HELD ION METER

A. Installing Contractor shall provide and utilize a minimum of one (1) Ion Meter for validation and provide these to the owner at the conclusion of all testing and validation of the project installation.

B. Power Requirements: Battery power with AC Power adapter option.

C. Equipment Requirements:

1. Ion counter must be capable of measuring the amount of both positive and negative ions in the air.
2. Range: 2 million ions per cubic centimeter.
3. Resolution: 10 ions per cubic centimeter.
4. Response Rate: 2 seconds.
5. Accuracy: +/-25% of reading.

D. Acceptable Manufacturers:

1. Alpha Lab Inc
2. Phenomenal Aire

PART 3 - EXECUTION

3.1 DELIVERY & PROTECTION

A. Deliver all equipment to the site as indicated in Division 1.

B. Contractor to perform installation and start-up to include installation of all accessories as required to make a complete and operating system.

C. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost to the Owner.

3.2 TESTING

A. Provide the manufacturers recommended electrical tests.

B. A report including ion levels for each of the measured spaces shall be submitted to the engineer for review. If a minimum of 500 ions per cubic centimeter is not achieved in any space, the manufacturer shall repair or replace equipment as required until this minimum ion level is met.

C. Use handheld ion measuring device, equal to that specified herein, to provide verification of ion presence in the Kitchen.

D. Use handheld ion measuring device, specified elsewhere herein, to confirm calibration of space mounted air ion counter(s) at substantial completion and one year after substantial completion.

3.3 COMMISSIONING & TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION

SECTION 23 52 16

HIGH EFFICIENCY CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with General Requirements in Division 1, and all referenced documents.

B. Comply with all other Sections as applicable.

1.2 SYSTEM DESCRIPTION

A. Furnish and install high efficiency condensing fire tube type boilers, flues, and accessories as indicated and specified herein.

B. All items of equipment shall meet or exceed scheduled capacities and shall be provided in quantities indicated.

1.3 QUALITY ASSURANCE

A. All work shall comply with the most recent editions, with amendments, of the local City Building, Mechanical, Energy Conversation, Fire and Plumbing Codes, and all other state and local Codes or ordinances.

B. Each boiler and accessories shall be certified and listed by the CSA International or American Gas Association (AGA) under the latest edition of the ANSI Z21.13 test standard.

C. All boilers shall be warranted for parts, with labor included, for the first year of warranty which shall start at "Substantial Completion". Provide an extended ten (10) year parts only warranty for the heat exchanger. Provide an extended one year (1) parts only warranty on the main control panel and associated electronics.

1.4 SUBMITTALS

A. Shop Drawings: Submit complete shop drawings in accordance with Division 1 and Section 23 0500.

B. Submit manufacturer's descriptive literature and installation instructions, along with materials of construction, quantities, sizes, input and output capacities, efficiencies, accessories, dimensions, weights, and any other descriptive literature necessary to fully evaluate submittals for compliance with these specifications.

C. Furnish complete power supply and control wiring diagrams for each piece of equipment.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Damaged, deteriorated, or wet materials shall be rejected and replaced.

B. Take all measures necessary to protect equipment from damage or vandalism during construction. Any such damage discovered shall be cause for rejection of equipment, in which case the Contractor shall repair or replace equipment at no cost to the Owner.

C. Storage and protection of equipment and accessories shall be in accordance with Division 1 and Section 23 0500.

D. Protect combustion air intake from dust during the active construction period.

PART 2 - PRODUCTS

2.1 CONDENSING HEATING WATER BOILERS

A. Boilers shall bear the ASME "H" stamp and shall be National Board listed for 150 PSI working pressure. Boilers shall be AGA or U.L. Listed; and be Industrial Risk Insurers (IRI), Improved Risk Mutuals (IRM), or Factory Mutual (FM) listed, and approved thereby when required by the Owner's insurance carrier which is the “Travelers Insurance Company”.

B. Each boiler shall be UL Listed, CSD-1 approved, ASME coded and stamped, and incorporate a gas train designed in accordance with FM or IRI.

C. Each boiler shall have an input (natural gas) and output MBH as listed on the drawing schedule (dependent upon return water temperature at 94% efficiency) when fired with natural gas. Boiler manufacturer shall publish known part load value efficiencies; the thermal efficiency must increase as the firing rate decreases.

D. Electrical service to each unit shall be 120V/1 16 amp service.

E. The boiler control panel shall incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display, on individual field replaceable circuit boards mounted within a single housing.

F. Each boiler shall have a UL Listing for zero side wall clearance and the installed weight shall not exceed 1700 lbs. (dry).

G. The boiler shall have an ASME approved relief valve setting of 125 psig.

H. Construction features of each boiler shall be as follows:

1. Boiler modules shall be natural gas fired, condensing fire tube design, with a modulating forced draft power burner and positive pressure vent discharge.
2. Each boiler burner shall be capable of a minimum 5 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. Burners shall be the nozzle mix design, with spark ignition and flame rectification. The burner head shall be either cast stainless steel or aluminum construction. All burner material exposed to the combustion zone shall be either stainless steel or aluminum construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and natural gas input. The modulating motor shall be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment.
3. Each boiler shall be capable of handling return water temperature down to 68 Deg.F. without any failure due to thermal shock of fireside condensation. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. The pressure vessel shall have a maximum water volume of 50 gallons. The boiler water pressure drop shall not exceed 10 psig at a 30 Deg. F. temperature differential flow. The boiler water connections shall be no less than 2-1/2" flanged and be 150 lb. ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25 in. thick wall and 0.50 in. thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code.
4. Each boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

    a. For Stainless Steel Heat Exchanges: The heat exchanger shall be constructed of 316L stainless steel fire tubes and tube sheets with a one-pass combustion gas flow design. The fire tubes shall be 5/8 in. OD with no less than 0.065 in. wall thickness. The upper and lower stainless steel tube sheet shall be no less than 0.313 in. thick. The pressure vessel/heat exchanger shall be all welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tube sheets

and heat exchanger is available by burner and exhaust manifold removal. Minimum access opening shall be no less than 13.5 in. diameter.

5. The exhaust manifold for each boiler shall be made of corrosion resistant porcelainized cast iron with a minimum 10" diameter flue connection. The exhaust manifold shall have a gravity drain for the elimination of the condensation with collecting reservoir.

I. Boiler Controls shall consist of the following:

1. The boiler control system shall be Underwriters Laboratories Recognized. The system shall either be integral to the boiler or separately wall mounted.
2. For separate wall mounted controllers, the main control panel shall consist of 6 individual circuit boards utilizing state-of-the-art surface-mount technology, in a single enclosure. These circuit boards shall be defined as follows:
    a. Display board incorporating LED display to read temperature and a VFD display module for all message annunciation.
    b. CPU board which houses all control functions.
    c. Electric low water cutoff board with test and manual reset functions.
    d. Power supply board.
    e. Ignition/stepper board incorporating flame safeguard control.
    f. Connector board.
    g. Each board shall be individually field replaceable.
3. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor.
4. The control panel hardware shall support both RS-232 and RS-485 remote communications. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporates a minimum of 8 separate status messages and 34 separate fault messages on a minimum 7” wide touch screen display.
5. The main control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features shall be called:
    a. Set point High Limit: Allows for a selectable maximum boiler outlet temperature and acts as a temperature limiting governor. It is a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree F. selectable band from the desired maximum boiler outlet temperature.
    b. Set point Low Limit: Allows for a selectable minimum operating temperature.
    c. Failsafe Mode: Allows the boiler to switch its mode to operate from an internal set point if its external control signal is lost, rather than shut off. This is a selectable mode and the control can be set to shut off the unit upon loss of external signal if so desired.
6. The boiler control system shall incorporate the following additional features for enhanced external system interface:
    a. System start temperature feature.
    b. Pump delay timer.
    c. Auxiliary start delay timer.
    d. Auxiliary temperature sensor.
    e. mA output feature which allows for simple monitoring of either temperature set point, outlet temperature, or fire rate.
    f. Remote interlock circuit.
    g. Delayed interlock circuit.
    h. Fault relay for simple remote fault alarm.
7. Each boiler shall utilize an electric single seated safety shutoff valve with proof of closure switch in its gas train and incorporate dual over-temperature protection with manual reset in accordance with ASME Section IV and CSD-1.

J. Boiler Management System (BMS):

1. Boiler Manufacturer shall supply, as part of the boiler package, a completely integrated Boiler Management System Programmer to control all operation and energy input of the multiple boiler heating plant. The Boiler Management System shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. The BMS controller shall have the ability to operate a minimum of 4 boilers per BMS panel.
2. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The BMS shall control the boiler outlet header temperature to within +2 Deg.F. of set point. The controller shall be a PID type controller for accurate temperature control with excellent variable load response. The BMS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.
3. Provide for an Indoor/Outdoor Reset Mode, the BMS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation.
4. When set on 4ma to 20ma Temperature Control Mode (currently not used), the BMS will operate the plant to vary header temperature set point linearly as an externally applied 4-20 ma signal is supplied.
5. When set on MODBUS Temperature Control Mode, the BMS will operate the plant to vary header temperature set point as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port.
6. The BMS controller shall have a LCD display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each module by a first-on first-off mode and provide for setback and remote alarm contacts.
7. Connection between central BMS system and individual modules shall be twisted pair low voltage wiring, with boilers “daisy-chained” for ease of installation.

K. The main control panel and the BMS shall utilize the MODBUS open protocol to interface with a third party building automation system. When the Building Automation System (BAS) does not have MODBUS protocol capability and interoperability is required, the installing contractor shall provide a MODBUS Gateway to act as an interface/translator between the BAS via either the RS-485 port of the main boiler control panel or the RS-232 port of the BMS controller.

L. Boiler emissions shall meet all current State of Texas requirements at the time the project is bid.

M. Reference Schedule on Construction Documents for required sizes, capacities, manufacturer upon which the design was based and model numbers.

N. All boilers shall be listed for Category IV venting without exception.

O. Acceptable Manufacturers:

1. Lochinvar Crest.
2. Aerco International.

2.2 GAS FIRED APPLIANCE FLUE PIPING

A. Provide a complete flue piping system sized specifically for each gas fired appliance and related installation conditions as indicated on the Drawings.

B. The vent system shall conform to all manufacturer’s recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure vent materials. The vent must be sized in accordance with the boiler manufacturers recommendations.

C. Install all flue vent piping, fittings, and flashings for all boilers in accordance with the vent system manufacturers recommendations.

D. Flues shall extend full size through roof with tall flashing and storm collars which shall terminate with a stainless steel Metalbestos or Breidert windproof cap as required by the boiler manufacturer. The fittings and lengths thereof shall be determined from actual field measurements.

E. Acceptable Manufacturer:

1. Metalbestos.
2. Metal-Fab.
3. Heat-Fab.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to each site as indicated in Division 1 and Section 23 0500.

B. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost to the Owner.

C. Any item of equipment or accessories damaged after installation, prior to "Substantial Completion", shall be repaired or replaced at no cost to the Owner.

3.2 INSTALLATION

A. Install all gas burning equipment and flues in accordance with the recommendations of the unit manufacturers, in compliance with all governing code authorities, and as indicated on the Drawings. Install floor mounted equipment level and on vibration isolation devices where specified herein or as indicated in other Sections of these Specifications.

B. Make final gas connections to all gas burning equipment with unions and gas cocks at each piece of equipment, to include sediment legs.

C. Install flues and windproof vent caps for each boiler, unless indicated otherwise. Flash and counterflash in accordance with the recommendations of the roofing system and flue system manufacturers. Seal all fittings with high temperature silicone caulking.

D. Adjust combustion blowers as required to obtain scheduled capacities or conditions as directed by the boiler manufacturer.

E. Provide local factory authorized manufacturer representative start-up service to supervise all phases of equipment start-up. Complete a letter of compliance and a standardized start-up report for boilers noting that all factory recommendations and installation instructions have been complied with. Include copy of completed reports in Close-Out Documents to include manufacturer model and serial numbers and extended warranties.

3.3 WARRANTY

A. Provide a one (1) year parts and labor warranty for all equipment and installations from the date of "Substantial Completion".

B. Furnish an extended ten (10) year parts only warranty for the pressure vessels/heat exchangers as specified herein.

C. Furnish an extended one (1) year parts only warranty on the main control panel assembly and for all circuit boards.

D. Submit all warranties will all close-out documents.

3.4 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Refer to Section 23 0500.

B. Provide three (3) copies of approved Submittals along with specific Installation and Operations and Maintenance Manuals for each piece of equipment to include a complete spare parts list.

END OF SECTION

SECTION 23 64 00

PACKAGED WATER CHILLERS, OUTDOOR AIR COOLED

(36-200 TONS CAPACITY)

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with General Requirements in Division 1, and all referenced documents.

B. Comply with all other Sections as applicable. Refer to other Divisions for coordination of this work with other portions of work specified therein.

1.2 SYSTEM DESCRIPTION

A. The work shall include installing microprocessor controlled packaged air-cooled rotary helical compressor type water chilling units.

B. Contractor shall connect piping, all required controls, factory furnished field installed accessories, appurtenances, insulation, hangers, supports, foundations, etc., for the water chilling units.

1.3 QUALITY ASSURANCE

A. Unit performance shall be rated and certified in accordance with American Refrigeration Institute (ARI) Standard 590, latest edition.

B. Unit construction shall comply with the latest editions of the National Electric Code (NEC), Underwriters Laboratory (U.L.), American Society of Mechanical Engineers (ASME) applicable codes, and American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standard 15.

C. Cooler shall be tested and stamped in accordance with ASME Code for a minimum refrigerant working side pressure of 278 psig, and a minimum water side pressure of 150 psig.

D. Air-cooled condenser coils shall be leak tested at 150 psig and pressure tested at 450 psig.

E. Unit shall be fully tested at the factory prior to shipment.

F. Factory authorized service personnel and routine repair parts shall be available within 24 hours of a trouble call.

G. All equipment and materials shall be new and unused.

1.4 SUBMITTALS

A. Product Data: Submit complete manufacturer's descriptive installation instructions for the configuration of equipment proposed to include:

1. Chilled water piping arrangement.
2. Equipment sizes, dimensions and weights.
3. Accessory installation methods.
4. Complete field and factory power and control wiring diagrams.
5. Equipment capacities at design parameters scheduled and specified.
6. Equipment installation methods.
7. Sound Power Levels at full load for each of the eight octave bands with and without sound attenuation package installed.

B. Shop Drawings: Submit in accordance with Section 23 05 00.

1.5 PRODUCT HANDLING

A. Equipment to be installed shall be delivered to the site where it shall be covered and protected. Material not properly protected and stored, and which is damaged or defaced during construction, shall be replaced at no cost to the Owner.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 AIR COOLED PACKAGED WATER CHILLER(S)

A. Provide single piece factory assembled units to meet the capacities scheduled which shall be rated to handle the listed water quantities without excessive pressure drops and without exceeding the manufacturer's rating on water velocities through the tubes.

B. Ratings shall be with a 0.0001 fouling factor on the water side of the cooler at 105 Deg.F. ambient air temperature. Chillers shall meet scheduled efficiency ratings.

C. Each unit shall include complete factory wiring, refrigerant piping, controls, operating refrigerant and oil charge (R-134a or R-410a), and special features as required prior to field startup.

D. Unit cabinet shall consist of a galvanized steel casing, zinc phosphatized, with an electrostatically applied baked enamel finish. Cabinet shall be capable of withstanding Federal Test Method Standard No. 141, Method 6061, 500 hour salt spray test.

E. Full load operation of each motor shall not exceed respective name plate ratings.

F. Compressors:

1. Compressors shall be accessible semi-hermetic rotary or screw type.
2. Each compressor shall be equipped with suction and discharge service valves, insert type factory sized oil crankcase heater, suction strainer, oil strainer, oil sight glass, and oil charging connection.
3. Compressor motors shall be refrigerant suction gas cooled, high torque, semi-hermetic induction type, maximum 3600 RPM for screw compressors, with inherent thermal protection in all three phases.
4. Each individual compressor shall be mounted on spring or neoprene pad vibration isolators, without exception, to minimize noise and vibration transmissions to obtain an isolation efficiency of 95%, or greater. Submit data to verify compliance.
5. Cycles per hour for each compressor shall not exceed six (6).
6. Screw compressors shall be individually enclosed by an acoustic sound blanket suitable for outdoor conditions. Sound blankets shall be made of one layer of acoustical absorbent textile fiber, minimum 5/8 inch thickness; one layer of anti-vibrating heavy material with a minimum thickness of 1/8"; and both of these layers enclosed with two (2) outer sheets of welded PVC or vinyl coated polypropylene reinforced fabric suitable for exposure to high ambient temperatures, be oil and water resistant, and be treated for ultra-violet resistance. Enclosures shall be factory or field mounted.
7. Compressors shall be controlled by manufacturer furnished and included Variable Frequency or Adaptive Frequency Drives to modulate the compressors for associated loading and unloading. This shall be accomplished by modulating the slide valve.

G. Evaporator (Cooler):

1. Evaporator shall be direct expansion shell and tube type with carbon steel barrel, polypropylene water baffles, and high efficiency internally enhanced seamless finned through copper tubes rolled into heavy carbon steel tube sheets.
2. Shell and tube heat exchanger heads shall be removable.

3. The evaporator and all cold surfaces, and adjacent surfaces, as required to prevent any sweating, shall be insulated with 3/4 inch thick closed cell foam insulation sheet, maximum K factor of 0.28, fitted and cemented in place, then painted with a resilient vinyl base paint to resist cracking.
4. The evaporator shall be designed, constructed, inspected, and stamped in accordance with ASME Code requirements.
5. Provide factory, or field installed, weld neck flanged water piping connections. Victaulic couplings not acceptable.
6. Equip with electric heat trace along the shell under the insulation to protect against cooler freeze-up down to -10 Deg.F. ambient.
7. Design shall include two independent refrigerant circuits such that failure of one circuit will not cause a total loss of capacity.

H. Air Cooled Condenser Coils:

1. The condenser coils shall be constructed of 3/8" O.D. seamless copper tubes mechanically bonded into plate type aluminum fins or micro-channel aluminum technology coils.
2. A sub-cooling coil shall be an integral part of the main condenser coil.
3. Tubes shall be cleaned, dehydrated, and sealed.
4. Provide manufacturer furnished, field installed coil air inlet, hail and vandal type, guard made of galvanized steel, PVC coated steel or painted steel to resist corrosion. Guard shall have rigid border for reinforced support and securement to equipment frame. Flat expanded metal is not acceptable. Guards shall protect condenser coils, compressors, and other refrigerant piping and specialties.

I. Condenser Fans and Motors:

1. Condenser fans shall be propeller type arranged for vertical air discharge and shall be direct drive fan motors, 3 phase type, with Class B insulation. Fans shall be variable speed ECM type motors.
2. Each fan shall be protected by a heavy gauge steel wire fan guard with ultra-violet inhibited PVC coating.
3. Fans shall have permanently lubricated bearings.
4. Fan shafts shall be inherently corrosion resistant.
5. Fans shall be statically and dynamically balanced.
6. Condenser fans, motors, and accessories shall include a factory installed sound reduction option to result in a nominal 2-4 dba reduction in overall sound power levels, versus, a standard unit operating without this option.

J. Each refrigerant circuit shall be completely independent of each other and include a factory insulated suction line, a hot gas muffler, high side pressure relief device, liquid line shut-off valves, suction and discharge manual shut-off valves, replaceable core filter drier, moisture indicating sight glass, liquid line solenoid valve, stepper motor actuated electronic expansion valve or thermostatic expansion valve, and complete operating charge of refrigerant R-134a or R-410a and compressor oil.

K. Controls:

1. Unit controls shall include the following minimum components.

   a. Microprocessor
   b. Power and control circuit terminal blocks
   c. External on/off control switch (inside cabinet) with indicating lights.
   d. Replaceable solid-state relay panel
   e. Leaving chilled water setpoint and control panel
   f. Thermistors and potentiometers.

2. Capable of performing the following functions:

   a. Recycling pump down control. Pump-out to occur at beginning and end of every circuit cycle. Each time the unit is energized, the oil pump shall be energized if all safety protective devices are satisfied.
   b. Unit controls shall provide recycling pump down protection at all times, including time clock system shutdowns on nights and weekends.

c. Capacity control based on leaving chilled water temperature and compensated by rate of change of return water temperature.
d. Limit the chilled water temperature pull-down rate at start-up to 1 Deg.F. per minute to prevent excessive demand spikes (charges) at start-up.

3. Unit shall be provided with automatic head pressure controls that permit satisfactory operation under low ambient conditions to 10 Deg.F., by cycling condenser fans or fan speed reduction in response to head pressure
4. The chiller on-board microprocessor controller shall be furnished with a BACNET MSTP standardized communications protocol chip that is compatible with and compatible with and communications directly with the Energy Management System.
5. During part load operation, the unit's refrigerant circuits shall be alternately unloaded in steps by providing automatic lead-lag control from accessory or standard cylinder unloaders and compressor staging to automatically alternate the lead circuit to ensure even compressor wear. Units shall have as their last step of unloading a hot gas bypass for stability at low capacity if units do not have unloading capability down to 15% of total capacity. Provide a minimum of two (2) stages of capacity for machines 50 tons and smaller in size. For units over 50 tons in size, provide one (1) additional stage of capacity for each incremental increase in capacity of 25 tons. Provide at least three (3) stages of control for units up to 75 tons in capacity, four (4) stages for units up to 100 tons capacity, with up to eight (8) stages of capacity control for units up to 200 tons in size.

L. Safeties:

1. Unit shall be equipped with thermistors and/or potentiometer and all necessary components in conjunction with the control system to provide the unit with the following protections:

a. Loss of refrigerant charge protection
b. Low water flow protection.
c. Low chilled water temperature protection
d. Low and high superheat protection
e. Low oil protection for each compressor circuit.
f. Low control voltage (to unit) protection.
g. Ground current protection for each compressor which shuts down compressor when no more than 2.5 supply amps are measured to prevent formation of acids.
h. High pressure switch.
i. Visual alarm signal (Light).

2. Compressors shall be equipped with the following manual reset-type protections:

a. Thermal overload or individual compressor circuit breaker or solid state device overload protection.
b. Pressure overload
c. Electrical overload through the use of definite-purpose contactors and calibrated, ambient compensated, magnetic trip circuit breakers. Circuit breakers shall open all three phases in the event of an overload in any one phase, or single phasing condition. Motor overloads that provide single phasing protection as well as overload protection will be acceptable, in lieu of circuit breakers.

3. Fan motors shall have inherent overcurrent protection.
4. Provide a factory installed and wired non-fused disconnect.

M. Diagnostics:

1. Diagnostic display module shall be capable of indicating the safety lockout condition through displaying a two-number code for which a legend shall be provided in control panel. Protections included for display shall be:

a. Compressor lockout
b. Loss of charge
c. Low water flow
d. Low oil pressure

e. Cooler freeze protection
f. High or low suction superheat.
g. Thermistor or potentiometer malfunction.
h. Entering and leaving water temperature.
i. Evaporator and condenser pressure.

2. Module must also be capable of performing a run test to verify operation of every switch, thermistor, potentiometer, fan, and compressor before chiller is started.

N. Operating Characteristics:

1. Unit shall be capable of starting and running fully loaded at outdoor ambient temperatures from 10 Deg.F., up to 115 Deg.F. per maximum load criteria of the most recent edition of ARI Standard 590, without special controls.
2. Unit shall be capable of starting up with 95 Deg.F. (35 Deg.C.) entering water temperature to the cooler.
3. Electrical Requirements:

a. Unit primary electrical power supply shall be connected to a single point.
b. Unit shall operate on three phase, 60 cycle power at the voltage shown in the equipment schedule.
c. Field power connection, control interlock terminals, and unit control systems shall be centrally located.
d. Power and starting components shall include separate fusing for the control circuit, fan circuits, starting contactors per compressor, solid-state compressor sequence start timers, adjustable 0 to 6 minute lockout timer anti-recycle protection on compressors, solid-state or suitable alternate compressor overload protection in all three phases, and unit power terminal blocks suitable for field connection from a single power supply.
e. A field supplied 115 volt control power supply, with fusing and disconnect, shall be utilized to supply the control circuit and cooler heat trace system.
f. Unit controls and power wiring shall be pre-wired and completely factory installed and labeled for ease of service and replacement
g. Provide integral unit mounted non-fused disconnect switch
h. All electrical control panel components and enclosures shall be rated for 65,000 amps short circuit.

4. Panel access doors shall key lock to prevent unauthorized access. Dead front panels shall protect service personnel against accidental contact with the line voltage components. Field install a key lock device on panels if not factory installed. Provide two (2) sets of keys for all locks.

O. Special Features:

1. Unit shall be capable of starting and running at outdoor ambient temperatures down to 10 Deg.F. with the addition of brine in the cooler circuit, wind baffles, and two-fan cycling solid state pressure switches with condenser coil temperature sensor.
2. Unit shall be equipped with electrically actuated suction cutoff type cylinder unloaders on both lead compressors and automatic lead-lag control.
3. Unit shall be field or factory equipped with refrigerant suction and discharge gauges with shut-off valves for each refrigerant circuit. An LCD Control Panel read-out will be acceptable in lieu of the specified gauges.
4. Unit shall have externally mounted field installed, factory furnished, chilled water flow switch which shall prove sufficient flow before the unit can operate. Use only differential pressure type switches rated for outdoor installation equal to a Johnson Controls, Inc. Model F61MG-1C or approved equal by McDonnell & Miller. Flow switch shall be vapor-proof SPDT, NEMA 4X switch, rated for 150 PSIG differential water pressure, rated for ambient temperatures from -20 Deg.F. to +250 Deg.F. Switch shall have 1" NPT connection for upright mounting in horizontal pipe. Alternately, a thermal dispersion flow switch standard with the chiller manufacturer may be used. Paddle type switches are not allowed.
5. Unit shall be equipped with an oil pressure safety switch to protect each compressor from loss of lubrication.

6. Provide corrosion resistant vandal /security grilles, with fasteners, for protection of all compressors, cooler, refrigerant piping and other components not otherwise protected.
7. Control compartment shall be equipped with a 115 volt convenience duplex receptacle outlet.

P. Provide an additional four 4 year warranty on the compressors after the one (1) year guarantee has expired. The first year of Warranty shall include all parts and labor.

Q. Provide factory authorized equipment manufacturer representative to perform field start-up and check-out services to include adjustment of controls, recording of operating conditions, and direction to the installing contractor of any corrective actions necessary for proper operation due to installation deficiencies.

R. Acceptable Manufacturers:

1. Trane.
2. York.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt.

B. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost.

3.2 AIR COOLED PACKAGED WATER CHILLER INSTALLATION

A. Install chiller including accessory components, auxiliary devices, water piping connections, external wiring, and controls required for chiller operation in accordance with manufacturer's instructions.

B. Verify that machine has a full charge of refrigerant and lubrication oil. Add as necessary and seal any leaks when discovered.

C. Locate chiller to provide the minimum required service and operating clearance. This shall include clearance for proper condenser airflow, cooler tube pull space, and service access to compressors and control compartments.

D. Provide an externally mounted flow switch for the chilled water piping. Locate each chiller flow switch indoors and across the chilled water piping of the respective primary chilled water pump, suction to discharge, dedicated to the chiller. Use differential pressure type switches.

E. Verify height of machine, top of fan discharge, is equal to the height of any surrounding screening material to prevent air recirculation into the condenser coils.

F. Provide factory authorized agent start-up services as specified herein to include submission of the start-up service record, typed for legibility. Handwritten reports are not acceptable.

3.3 OPERATING PROCEDURES AND REQUIREMENTS

A. Operating and service instructions in illustrated and bound form shall be furnished by the manufacturer, three copies, within 30 days of "Substantial Completion".

B. At startup, the equipment manufacturer shall furnish skilled personnel to supervise, check out performance, make any required adjustment, place the unit in service, and instruct the Owner's personnel for a full period of four (4) hours. Start-up of chillers shall be performed by a service representative of the unit manufacturer.

C. The manufacturer of each item of equipment shall provide complete wiring diagrams to the Electrical and Temperature Controls Contractor and shall provide drawings indicating all required external wiring and arrangements of connections.

3.4 WARRANTY

A. Transfer the full Warranty to Owner to include all parts and labor for a full one year period after the cooling system is put into sustained operation to obtain building cooling effect and accepted as a completed installation by the Owner which shall begin at "Substantial Completion".

B. Transfer any and all other warranties as applicable over to the Owner at the completion of construction, "Substantial Completion", including the extended four (4) year compressor warranties.

END OF SECTION

SECTION 23 73 23

AIR HANDLING EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Conditions of the Contract and Division 1 - General Requirements are hereby made a part of this section.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other portions of work, as required.

1.2 SYSTEM DESCRIPTION

A. Scope of Work includes the furnishing and installation of all air handling units, fan coil units, roof mounted air handling units, hangers, supports, and appurtenances as indicated herein.

B. All items of equipment shall meet or exceed scheduled capacities and shall be provided in quantities indicated.

C. Equipment shall be purchased and installed by the Contractor who shall install the equipment with field installed accessories and make connections to other components to make a complete and operating system.

1.3 QUALITY ASSURANCE

A. All air handling unit electrical equipment shall be U.L. Listed.

B. All water coils shall be rated for the application listed in accordance with the Air-Conditioning, Heating and Refrigeration Institute (AHRI) Standard 410.

C. All fans shall be rated in accordance with the Air Moving Council Association (AMCA), and bear the label thereof.

1.4 SUBMITTALS

A. Submit complete submittals and Shop Drawings in accordance with Section 23 05 00.

B. Submittals shall include manufacturer's descriptive literature, material types, sizes, finishes, treatments, quantities, required accessory descriptions, capacities, fan curves, installation details, wiring diagrams, and any other descriptive literature necessary to fully evaluate the submittals for compliance with these Specifications.

1.5 INSTALLATION, OPERATION, AND MAINTENANCE BROCHURES

A. Furnish all installation manuals required by a qualified mechanic for proper installation of equipment. Manuals shall be provided with equipment and be attached thereto.

B. Complete bound Operating and Maintenance Brochures shall be retained by the successful equipment supplier for submittal, in triplicate, a minimum of 30 days prior to completion of construction.

1.6 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 CENTRAL STATION AIR HANDLING UNITS

A. Each unit shall be of the horizontal or vertical type, have the performance capabilities as scheduled and be arranged as indicated on the Drawings.

B. The sections which constitute the completed unit shall each be completely assembled at the factory in a double wall sheet metal housing appropriately furnished, and shipped as a complete unit or in sectionalized units suitable for field assembly. They shall be factory assembled, or be capable of job site assembly, into a complete unit having physical characteristics as indicated. All side and end panels shall be removable without reducing structural integrity of the unit.

C. Each air unit shall be constructed of heavy gauge reinforced steel panels lined with one inch (1") thick mat faced glass fiber insulation not lighter than 3 lb. density. Alternately use two inch (2") thick 1.5 lb. density insulation. Such lining shall be cemented to the inside portion of the unit casing and additionally be secured with sheet metal binding strips. The lining material shall be waterproof and have a flame spread rating of less than 25 and shall comply with the requirements of NFPA Bulletin 90-A. This insulation shall be covered with the metal inner wall as described herein. As a second alternate to the above, air handling units may have casing construction consisting of a high density foam type insulation sandwiched between inner and outer galvanized steel panels with a minimum overall R-value of 13.0. Minimum inner and outer steel panel thickness shall be as standard with the manufacturer for that style of construction. Structural members shall be minimum 16 gauge in thickness.

D. Provide factory-installed base rails on each air handling unit. Alternately provide an external support kit on the base of the unit to effect base rail support. External support kit or base rails shall be used for ceiling suspension, external isolation, or with housekeeping pads. Contractor shall be responsible for adjusting the height of housekeeping pads when unit is not of sufficient height to properly trap unit. The housekeeping pad height designated on the Drawings may be reduced when sufficient P-trap depth, with insulation, can be obtained with a lesser pad height. Approval must be obtained through the Engineer. Unit mounting devices not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.

E. All access doors, where specified herein, shall be of double wall construction with inner metal liners and have Ventlock 100 or 140 safety type latches. Alternately, quarter turn 5/16" Allen wrench operated integral latches will be acceptable. Provide tool for each air handling unit for operation of latches. Provide Ventlock 220 door pulls, or equal, on doors larger than 30" x 30". Screw attached doors are not acceptable. All access doors shall have continuous vinyl type bulb seals for a low leakage rate. Hinges shall be either continuous corrosion resistant metal piano hinges or consist of multiple heavy duty corrosion resistant metal or fiber reinforced nylon hinges.

F. Condensate drain pans shall have double wall construction with threaded drain connection on one end. Condensate drain pans shall be insulated with one inch (1") thick fiberglass cemented between a heavy gauge galvanized steel outer pan and minimum 16 gauge type 304 stainless steel inner pan (exposed to air stream). Inner pan shall be coated with corrosion resistant elastomeric based material. Insulation and adhesive shall comply with NFPA Bulletin 90-A flame spread and smoke generation requirements. Drain pan shall be sloped in two directions for positive drainage.

G. Fan Section:

1. Fan sections shall be double wall construction and be made of minimum 18 gauge G-90 galvanized steel or 18 gauge chemically cleaned phosphatized steel given a protective enamel finish. The inner liner shall be perforated, minimum, 20 gauge galvanized steel. Fan sections shall have a formed channel base for mounting of fan and casing panels. Each unit shall have either a Class II airfoil fan wheel and scroll or forward curved type as scheduled, and as required to meet scheduled

capacities for stable operation. Fans shall be double width, double inlet type for forward curved fan wheels and backward curved airfoil blades with double inlet for air foil fans. Wheels shall be bonderized steel painted with baked enamel, galvanized steel, or welded aluminum. For sandwiched foam panel casing construction, the minimum outer casing steel panel thickness shall be as standard with the manufacturer. Sandwiched foam panel construction with a total capacity over 6,500 CFM will require one inch (1") thick fibrous insulation perforated metal liners in the fan section for enhanced acoustical attenuation.

2. Fan shafts shall be solid steel C1040; turned, ground, and polished.
3. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at the maximum rated fan speed and motor horse power. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed, and shall be statically and dynamically balanced as an assembly. The entire assembly shall be IRD 245 2 plane balanced to 1.0 mil or less total displacement as measured at each bearing pad.
4. For units utilizing multiple fans in a fan section, a fan curve shall be provided showing the performance of the entire bank of fans at design conditions. In addition, a fan curve shall be provided showing the performance of each individual fan in the bank of fans at design conditions. Also a fan curve shall be provided showing the performance of the bank of fans, if one fan is down. The percent redundancy of the bank of fans with one fan down shall be noted on the fan curve or in the tabulated fan data
5. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.
6. All fans, including direct drive plenum fans, shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
7. Provide factory furnished backdraft type dampers on the discharge of each fan in the fan array to allow for other fans to continue to operate if there is a single fan failure. Frame shall be 0.125” wall thickness extruded aluminum with galvanized steel braces at all corners. Blades shall be 0.070 wall thickness extruded aluminum. Blade edge seals shall be extruded vinyl mechanically locked into the blade edge. Bearings shall be corrosion resistant long line synthetic. Linkage shall be ½” tie bar with stainless steel pivot pins. Damper shall be designed for 3500 FPM maximum spot velocities.
8. Vibration isolation of the entire fan, motor, and drive assembly to be by use of 2 inch deflection springs internally mounted at the factory, together with fan discharge neoprene flexible connection and thrust restraint springs. All fans 6,500 CFM, or larger, shall be internally isolated.
9. Fan motors shall be factory mounted inside the fan section casing, on slide rails having 2 adjusting screws. Motors shall be the open drip proof (ODP) type. Motor speed shall be 1750 RPM. Motors over one horsepower in size shall be NEMA (premium) efficiency type similar to Baldor Super-E, Century E Plus III, General Electric "XD Ultra" or U.S. “NEMA Premium” as specified in Section 23 05 13.
10. Fan sections containing multiple fans shall be provided as indicated on the schedule and drawings. Each fan shall operate in parallel to each other fan in the array. The fans shall be SWSI plenum type with high-efficiency AF blades. Fans shall be direct-driven. Fan wheels shall be aluminum. The horsepower characteristic of the fans shall be non-overloading.
11. Fan sections containing multiple fans shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

12. In lieu of a motor overload type control panel, each fan in the array shall be independently powered and controlled by a dedicated separate field mounted Variable Frequency Drive (VFD), such that a two (2) fan array would have two (2) independent VFDs, one per motor. The fans shall be controlled together as noted in the section above with common control signal, but shall be powered separately and able to be independently isolated, grounded, and protected.
13. Provide a minimum of one (1) 60" X 18" access door to fan casing, and any factory fabricated plenum sections. Doors shall have continuous vinyl jamb seals for an airtight seal. Fan sections or plenums too small to accommodate this size access door shall have an access door as large as the casing or plenum size will allow.

H. Coils:

1. Coils installed in air units shall be of the type that is standard with the unit manufacturer and shall be complete with continuous heavy-duty supporting structure. Coils shall be the slip-in and slip-out type for ease of replacement from the coil connection side. The type and capacity of each coil assembly shall be as scheduled on the Drawings and as specified elsewhere herein. Coils shall be erected and connected in the arrangements shown. Generally, unless indicated otherwise, heating coils shall be located in the pre-heat position.
2. Coil performance shall be rated and certified in accordance with AHRI Standard 410.
3. Chilled and Heating water coils shall have aluminum plate fins, minimum 0.006 inch thickness, maximum 144 fins per foot, with belled collars bonded to 1/2 inch minimum OD, minimum 0.016 inches thick wall, copper tubes by mechanical expansion. Coil sections shall have casings manufactured the same as the fan casings, except the inner liner shall consist of a 20 gauge galvanized steel solid panel section. Coil working pressure shall be 200 PSIG at 200 Deg.F. for chilled water and 175 PSIG at 400 Deg.F. for heating water. Coils shall be drainable and have non-trapping circuits. No turbulence promoting devices shall be permitted inside the tubes. Coils shall have seamless copper tube, headers with threaded, 2" and smaller, or flanged connections, 2-1/2" and larger. Alternately, install flanges on site. Headers shall have drain and vent connections. Provide minimum six (6) rows for cooling coils and two (2) rows for heating coils, unless specifically noted on the air handler schedule to use one (1) row for heating coils. Use maximum 12 fins per inch for cooling coils and 10 fins per inch for heating coils.
4. All coil connections shall have right hand connections looking downstream of unit, unless scheduled or indicated otherwise. Refer to Drawings.
5. Provide a minimum of one (1) 60" X 18" access door panel to each coil section casing or the maximum size possible to be installed thereon whenever the casing size cannot accommodate the specified size. All units shall have access doors, unless full access is provided to both sides of the coil section through the fan and filter section access doors.
6. Coil section inner wall, floor and ceiling panels shall all be minimum 20 gauge galvanized steel solid panels.
7. Heating coils shall be in the pre-heat position unless indicated otherwise. AHU-A2 shall have a pre-heat and re-heat coil

I. UV Light Array:

1. Refer to Specification Section 23 05 66 for additional information. Light array can be provided by manufacturer or installed separately in field. UV light array shall only be by one of the listed manufacturers in the associated specification and shall be designed to control the airborne contaminant noted in the specification on equipment schedule.

J. Filter Sections:

1. Low Velocity (Angled) Filter Sections shall be provided by the air handling unit manufacturer for all air handling units, with the same casing construction as described for fan sections (solid or perforated metal inner wall). All units shall have angled filter sections, unless indicated otherwise on the Drawings. Filter racks, V-shaped, shall be capable of receiving 2" or 4” thick filters of standard sizes, and shall be constructed of heavy gauge galvanized steel slide rails. Filter sections shall have full size hinged access doors on each side of the casing. Doors shall include a minimum of two quarter turn fastening handles. Provide one (1) set of two inch (2") thick Farr 30/30 filters for each unit, for construction type filters. Provide 4” thick MERV 13 filters for unit operation and TAB testing.
2. Furnish flat, or high velocity, filter sections, only where indicated on the Drawings, with two inch (2") or four inch (4”) heavy gauge galvanized steel slide rail filter racks and a complete set of two inch

(2") thick Farr 30/30 filters with unit for construction. Filters shall be accessible through both sides of unit by use of hinged filter access doors with suitable fasteners.

3. At the time of construction, before operating equipment, all filters shall be installed to fully protect coils and air distribution system from dirt and debris. Replace filters as specified in Section 23 30 00 with MERV 13 type filters.
4. Provide a differential pressure gauge including magnahelic gauge across each bank of filters. Provide set of contacts to notify remote monitoring system of maximum resistance. Range shall be from 0.0 - 1.0 inches W.G. unless indicated otherwise.
5. Filter sections shall be double wall same as the fan and coil sections.

K. Plenum sections shall be field or factory fabricated and shipped, as applicable, with other sections of the air handling unit, at the option of the Contractor.

L. Acceptable Manufacturers:

1. Trane.
2. Carrier.
3. York.

2.2 FAN COIL UNITS

A. Fan coil units shall have the characteristics indicated and be furnished completely assembled to include casings, enclosure, or plenums as indicated, finned tube coils, fan and motor sections, belt drive assembly, filter racks, and other specified accessories to meet scheduled capacities.

B. Fan coil units shall be rated and certified by ARI and be U.L. approved.

C. Water coils shall be standard coils furnished by fan coil unit manufacturer and rated for scheduled capacities. Coils shall be ARI rated and certified. Coils shall be made of 3/8" or 1/2" O.D. copper tubes, minimum 0.016 inches tube wall thickness, mechanically expanded into aluminum plate fins, rated at 250 PSIG and leak tested at 350 PSIG minimum air pressure. Provide manual type air vent with each coil. Coils shall have a minimum six (6) rows for cooling and two (2) rows for heating applications, and have a maximum of ten (10) fins per inch. Both heating and cooling coils shall be installed within the same cabinet. Coil piping connections shall be made in the side of the unit casing, with grommets, with unit penetrations being provided by the manufacturer. Generally the heating coil, when provided, shall be in the pre-heat position unless indicated otherwise. For units with no outside air, provide heating coil in the re-heat position.

D. Fans shall be statically and dynamically balanced and be of indicated capacities. Fan wheels shall be constructed of a minimum of 22 gauge galvanized steel and be forward curved design. Furnish permanently lubricated long life heavy duty ball bearings. All motors shall be provided with thermal overload protection.

E. Cabinets shall be made of minimum of 18 gauge G-90 galvanized steel or 18 gauge cold rolled steel primed and coated with a baked enamel paint. Cabinets shall be insulated with a minimum 3/4 inch thick, 1.5 pound density, coated glass fiber insulation complying with NFPA No. 90A. Provide supply and return duct collars. Condensate pan shall be made of 18 gauge galvanized, or Type 304 stainless, steel and be insulated to prevent condensation. Cabinet shall have four (4) support points for insertion of 3/8" round threaded hanger rods. Provide two (2) removable panels for access to and removal of internal components from both sides. Coil piping shall not obstruct access to internal components requiring removal or periodic servicing.

F. Furnish side access flat filter racks, capable of accepting one or two inch (1" or 2") thick filters. Two inch (2") thick filters will be used in this application. Furnish filters and spare media same as for constant volume air handling units. All filters shall be standard filter sizes of all filter manufacturers.

G. Acceptable Manufacturers:

1. Magic-Aire Series BHW, or approved equals by:
2. Carrier.
3. Trane.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to each site as indicated in Division 1.

B. Perform installation and start-up to include installation of all accessories as required to make a complete and operating system.

C. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost.

3.2 CENTRAL STATION AIR HANDLING UNITS

A. Install air handling units level on housekeeping pads, which shall extend four inches (4") larger than the unit in each dimension.

B. Provide for positive gravity drainage of coil condensate. Pipe condensate full size of unit connection as detailed on the Drawings to include a P-trap. Verify proper drainage is attained from each unit.

C. Remove all shipping restraints and unfasten any hold down fasteners.

D. Verify correct rotation of fan and proper wiring of motor to include verification of proper line voltage and insuring actual motor amps does not exceed name plate amps.

E. Lubricate all greaseable ball bearings with manufacturers suggested lubricant.

F. Adjust belt tension and align belts to eliminate wear and excessive vibration per manufacturer’s recommendations.

G. Verify starter (motor controller) motor overload heaters are sized within the nameplate motor amp range, i.e., a heater range of 8.0 - 9.0 amps would only be suitable for a motor within that range. A motor nameplate of 9.1 amps would need a different heater.

H. Adjust fan drives as required to obtain scheduled capacities as directed by the Test and Balance firm to include one sheave and belt replacement, as required thereby.

I. Lubricate all greaseable ball bearings with manufacturers suggested lubricant.

J. Replace filters as specified in Section 23 30 00. Keep the filter section loaded with filters at all times. Provide the new specified type just prior to the commencement of the Test and Balance work. Do not operate any unit without proper filters in place.

K. Make piping connections so as not to interfere with future coil removal work, access door operation, filter removal and maintenance, or motor and drive maintenance.

L. Provide power to units for operation for system balancing in sufficient time to perform TAB work prior to Substantial Completion.

3.3 CLEAN-UP

A. Clean coils and condensate pans after installation of air handling units and fan coil units is complete.

B. Vacuum clean all debris from inside air handling units other fan casings, and plenums with internal duct lining.

END OF SECTION

SECTION 23 75 33

CUSTOM PACKAGED ROOFTOP UNITS (100% OUTDOOR AIR UNITS)

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with General Requirements in Division 1 - General Requirements, and all referenced documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other trades as required.

1.2 SYSTEM DESCRIPTION

A. The work shall include installing new specialty semi-customized electric cooling gas heating roof mounted air conditioning units to meet scheduled capacities and to effect outside air control by modulation and space relative humidity control.

B. Contractor shall connect all ductwork, condensate drain piping, gas piping, roof curbs, temperature controls, power supply, disconnects, factory furnished field installed accessories, appurtenances, insulation, supports, flashing, etc. to make a complete and operational system.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality complying with all standards specified herein.

B. All equipment and materials shall be installed in a workmanlike manner by trained and experienced mechanics as recommended by the equipment manufacturer and as detailed on the Drawings.

C. Units shall be rated in accordance with AHRI Standards 210/240 or 340/360 and 270, as applicable, and be capable of starting and running at ambient outdoor temperatures as high as 115 Deg.F. while operating to meet the maximum load requirement.

D. Units shall be designed to conform to ASHRAE Standard 15, latest revision.

E. Units shall be U.L. or ETL Tested and Certified in accordance with ANSI Z21.47b Standards as a total package for safety requirements.

F. Insulation and adhesive shall meet NFPA 90A and B requirements for flame spread and smoke generation.

G. Gas fired units shall be American Gas Association (AGA) certified.

H. Unit casings shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500 hour salt spray test.

I. Each individual unit shall be subjected to a completely automatic factory run test on the assembly line. Each unit shall pass this run test, repair as necessary, prior to being allowed to be shipped to the project site.

J. Unit manufacturer shall establish an inventory parts program with the Denton Independent School District to insure the timely availability of the most common parts requiring repair or replacement. Inventory lists shall be determined by mutual agreement with the Owner.

1.4 SUBMITTALS

A. Provide detailed product data by submitting manufacturer's descriptive literature and installation instructions and method for the configuration of equipment proposed, including wiring diagrams, piping connections, ductwork connections, capacities at scheduled conditions, fan capacity curves, accessories furnished, and other descriptive literature necessary to fully evaluate the Submittals for full compliance with these specifications.

B. Shop Drawings: Submit in accordance with Sections 23 05 00

1.5 PRODUCT HANDLING

A. Deliver all equipment to the site where it shall be covered and protected. Material not properly protected and stored and which is damaged or defaced during construction shall be replaced at no cost to the Owner.

B. Storage and protection of materials shall be in accordance with Section 23 05 00.

1.6 INSTALLATION, OPERATION, AND MAINTENANCE BROCHURES

A. Furnish all installation manuals required by a trained and experienced mechanical technician for proper installation of equipment. Manuals shall be provided with equipment and be attached thereto, or contained therein. These shall be used for installation and equipment start-up.

B. Furnish three (3) complete bound Operating and Maintenance Brochures with spare parts lists, which shall be submitted at "Substantial Completion".

C. At project close-out, furnish an extended four (4) year compressor and 14 year heat exchanger warranty certificates to begin at the end of the first year warranty. The first year Warranty includes all parts and labor and begins at Substantial Completion. Indicate specific model and serial numbers for all items of equipment furnished to be Warranted. Extended warranties cover parts only.

PART 2 - PRODUCTS

2.1 SEMI-CUSTOM PACKAGED ROOFTOP A/C UNITS (100% OUTSIDE AIR)

A. Products shall be provided by the following manufacturers:

1. Addison.
2. Valent.
3. Daikin.
4. Trane.

B. Basic Requirements:

1. Use R-410A refrigerant.
2. Utilize direct drive supply fans.
3. Be provided with double wall cabinet construction throughout.
4. Casing insulation shall be a minimum R-value of 13.
5. Provide with stainless steel drain pans.
6. Provide with hinged access doors with lockable handles.
7. Provide with variable capacity compressor with 10-100% capacity range, using a VFD controlled variable speed compressor.
8. All other provisions of the specifications contained herein shall also be satisfactorily addressed.

C. General Description:

1. Packaged rooftop units shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, gas heaters, and unit controls.

2. Units shall be factory assembled and tested including leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
3. Units shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
5. Estimated sound power levels (dB) shall be shown on unit ratings sheets.
6. Installation, Operation and Maintenance manuals shall be supplied within the unit.
7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
8. Unit nameplates shall be provided in two (2) locations on each unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

D. Construction:

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929-11 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, reheat coil, heaters, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Units shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Units shall include lifting lugs on the top of the unit.
11. Units base pan shall be provided with 1/2 inch thick foam insulation.
12. Units shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.
13. Unit shall have modulating return air and outside air dampers. No relief/exhaust air fans shall be provided.

E. Electrical Requirements:

1. Units shall be provided with standard power block for connecting power to the unit.
2. Units shall be provided with factory installed and factory wired, non-fused disconnect switch.
3. Units shall be provided with factory installed and factory or field wired (see RTU schedule) 115V, 13 amp GFI outlet with outlet disconnect switch in the unit control panel.
4. Units shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.
5. Units shall be provided with manual reset low temperature limit controls which shut off the unit when the discharge temperature reaches a field adjustable setpoint.

6. Units shall be provided with blower auxiliary contacts on the low voltage terminal block which close when the supply fans are energized.
7. Units shall be provided with remote stop/start terminals which require contact closure for unit operation. When these contacts are open the low voltage circuit is broken and the unit will not operate.

F. Supply Fans:

1. Units shall include direct drive, unhoused, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
3. Motors shall be standard (premium) efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

G. Cooling (Evaporator) Coils:

1. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and **304 stainless steel end** casings. Fin design shall be sine wave rippled.
2. Coils shall have interlaced circuitry and shall have 6 row high capacity coils.
3. Coils shall be hydrogen or helium leak tested.
4. Coils shall be furnished with factory installed expansion valves.

H. Refrigeration System:

1. Units shall be factory charged with R-410A refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam insulated panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and factory installed liquid line filter driers.
7. Unit shall include a variable capacity or variable speed scroll compressor on the lead (all) refrigeration circuit(s) (for each circuit) which shall be capable of modulation from 10-100% of its capacity.
8. Lead refrigeration circuit(s) shall be provided with a modulating hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
9. Each refrigeration circuit shall be equipped with a liquid line sight glass.
10. Each capacity stage shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.
11. Each capacity stage shall be equipped with an adjustable, 20 second delay timer to prevent multiple capacity stages from starting all at once.

I. Air-Cooled Condensers:

1. Condenser fans shall be vertical discharge, axial flow, direct drive fans.
2. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
3. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
4. Coils shall be hydrogen or helium leak tested.
5. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockouts.

J. Gas Heating System:

1. Units shall include a natural gas furnace with full modulating capacity control.
2. Stainless steel heat exchanger furnace shall carry a 15 year non-pro-rated warranty, from Substantial Completion.
3. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
4. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
5. Unit shall include a single or dual gas connection, as required, and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
6. Natural gas furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment.
7. Gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity.

K. Filters:

1. Units shall include two (2) inch thick, pleated panel filters with an ASHRAE MERV rating of 11, upstream of the cooling coil.
2. Unit shall include a Magnehelic gauge mounted in the controls compartment.

L. Outside Air/Economizer Section:

1. Units shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge and end seals.
2. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper.
3. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511.
4. Damper assembly shall be controlled by spring return fully modulating DDC actuator.
5. Units shall include outside air opening bird screen, outside air hood.

M. Controls:

1. Provide the units with a terminal strip for field mounted controls by others or with a factory mounted controller as indicated below.
2. Factory Installed and Factory Provided Controller with LCD display:
    a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
    b. Controller shall be capable of standalone operation with unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
    c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
    d. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
    e. Makeup Air Controller:
        1) Units shall modulate cooling with constant airflow to meet kitchen exhaust make-up air loads. Cooling capacity shall modulate based on supply air temperature.
        2) With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet outside air humidity loads and prevent supply air temperature swings and overcooling of the space.
        3) Unit shall modulate heating with constant airflow to meet ventilation outside air loads. Heating capacity shall modulate based on supply air temperature.

3. Provide BACNET MS/TP compatible standardized communication chip to communicate directly to an Owner's BACNET protocol energy management system.

N. Unit Roof Curbs:

1. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
2. Knockdown curbs (with duct support rails) shall be factory furnished for field assembly.
3. Solid bottom curb shall be factory assembled and fully lined with 1 inch neoprene coated fiberglass insulation and include a wood nailer strip. (Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.)
4. Curbs shall be minimum 18" tall.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to each site. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt.

B. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost.

C. During construction, take all steps necessary to protect equipment from damage or vandalism. All damage or vandalism shall be repaired at no cost to the Owner.

3.2 ROOFTOP A/C UNITS

A. Install manufactured roof curbs on the roof square and level to receive the units. Provide and install additional steel framing as required to provide safe, noiseless, operating systems. Locate units with condensate drain pans sloped for positive pan drainage.

B. Coordinate the electrical services and control wiring with the Electrical Systems Installer. Coordinate the condensate drainage system with the Plumbing Systems Installer. The manufacturer of each item of equipment shall provide complete wiring diagrams to the Electrical Systems Installer and shall provide drawings indicating all required external wiring, piping and arrangement of all field connections.

C. Coordinate the exact unit locations with the structural systems and the ceiling systems below as actually installed. Shim roof curbs, or adjust as applicable, to make entire top of each curb level.

D. Make all sheet metal supply and return duct connections with flexible duct connections below the roof.

E. Install sound and vibration isolation devices as detailed on the Drawings. Install continuous 2" wide by 3/8" thick neoprene isolation strip along the full perimeter of the roof curb for a complete air seal.

F. Provide for one (1) additional set of fan sheaves for each belt drive unit, as required by the Testing and Balancing Firm, to obtain design air flows. For bidding purposes provide one (1) set sheaves, and belts where required, as follows:

# of Units	Minimum # Sets of Belts & Sheaves
1 - 5	3
6 - 10	5

G. Gas furnaces shall be jumpered to operate at full fire, with the supply fan operating, for a minimum of thirty (30), but not more than sixty (60), minutes to burn off dust, lint, and factory produced oil films. Remove jumper after this process is completed. Perform this work in such a fashion as not to void equipment warranties. Documented factory run tests conducted for 30 minutes will be considered, but must be approved by the Engineer.

H. At start-up, have all units served by a gas pressure regulator, external to the units, operated at full fire, and adjust gas supply pressure to these units to be between 7-10 inches W.G. Document in writing actual pressure measure going into unit, as well as manifold pressure. Include this information in Start-up Report to be submitted with Close-Out Documents.

I. Verify all items internal to unit controlled by the terminal equipment controller functions when commanded to operate. Verify that all dampers fully modulate and that they close fully when commanded to be in that position.

J. Do not operate units without specified air filters being installed. Failure to do so will result in the Contractor cleaning coils at no cost to the Owner.

K. Tighten and align fan belts and lubricate all bearings. Verify proper rotation of moving parts.

L. Install all field installed accessories.

M. Make all power and control wiring connections.

N. Verify correct operation of equipment, accessories, and control devices.

O. Follow the manufacturers' directions for start-up of rooftop A/C units. The Contractor may provide the start-up of the units provided only if trained and authorized by the equipment manufacturer of the units furnished and installed. Equipment manufacturer supplier shall provide equipment performance checkout with the assistance of the Contractor and shall provide a report to the Engineer which shall note any abnormalities they observed. Contractor shall make any wiring changes as required to the control transformer to accommodate the actual job voltage supplied.

P. Provide a 1" thick roll filter media on each return air duct opening during construction until the final duct and return air grilles are installed.

Q. Provide a Start-up Data Report for all units which shall include:

1. Outside air temperature, entering and leaving air temperature conditions of evaporators and condensers, compressor voltage and amps, indoor blower voltage and amps, entering gas pressure, and pressure drop across evaporator coil.
2. Operate all units in both heating and cooling modes with outside air being introduced.
3. Provide report with final request for payment (Required prior to project Close-Out).
4. Coordinate testing with Test and Balance firm after units are started up.

R. Manufacturer shall set up an account with the school district's maintenance department that establishes part inventories, restocking capabilities, and documentation and program for all warranty work to be performed.

3.3 CLEANUP

A. Clean evaporator and condenser coils, condensate pans and condensate drain piping after installation of rooftop A/C units is complete.

B. Clean all debris from inside rooftop A/C unit casings

C. Replace air filters with new as specified in Section 23 3000.

3.4 OPERATING PROCEDURES AND REQUIREMENTS

A. Operating and service instructions in illustrated and bound form shall be furnished by the manufacturer, three (3) copies, at "Substantial Completion".

B. At startup, the equipment manufacturer shall furnish skilled personnel, separate from the installing contractor’s work force, to supervise, check out performance, make any required adjustments, place all units in service, and instruct the Owner's personnel for a full period of two (2) hours for each 15 units provided. Fill out a manufacturers start-up report, to be typewritten, for each new unit installed which shall reflect the operating conditions of the electrical power supply, refrigeration system and gas furnace.

3.5 WARRANTY

A. Transfer Full Parts and Labor Warranty to Owner for a full one (1) year period beginning at "Substantial Completion".

B. Transfer any and all other warranties as applicable over to the Owner at "Substantial Completion", including extended 4-year compressor warranties, as applicable, on refrigeration equipment, and extended 15-year warranties on aluminized steel heat exchangers. Extended warranties cover parts only.

END OF SECTION

SECTION 23 81 27

DUCT-FREE SPLIT SYSTEMS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with General Requirements in Division 1, and all referenced documents.

B. Comply with all other Sections as applicable.

1.2 SYSTEM DESCRIPTION

A. The work shall include installing remote air cooled heat pump condensing units and duct-free split system direct expansion (DX) evaporator fan coil units where indicated on the Drawings to meet scheduled capacities. Heat pumps shall be matched with indoor unit coils.

B. Contractor shall connect all refrigerant piping, refrigerant specialties, required controls, starters, field installed accessories, appurtenances, insulation, hangers, supports, foundations, etc. to make a complete and operational system.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality, complying with all standards specified herein.

B. All equipment and materials shall be installed by technicians trained to perform this type of work, having had experience with similar type of equipment, and shall be in full accordance with the recommendations of the manufacturer.

1.4 SUBMITTALS

A. Product Data: Submit complete manufacturer's descriptive literature, installation instructions, wiring diagrams, electrical characteristics at the scheduled voltage and phase, piping connections, and matched capacity ratings at specified conditions, accounting for proposed refrigerant line size, routing and length of run. Indicate all accessories furnished, sizing of refrigerant piping, and other descriptive literature to verify conformance to these specifications.

B. Submit system piping schematic with recommended pipe sizes, piping routing, fittings, and proposed equipment configuration.

C. Submit in accordance with Division 1.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during transit or storage shall be rejected and replaced at no cost.

B. Storage and protection of materials shall be in accordance with General Requirements and Division 1.

1.6 INSTALLATION, OPERATING, AND MAINTENANCE MANUALS

A. Furnish all installation manuals required by an experienced and trained technician for proper installation of equipment. Manuals shall be provided with equipment and be attached thereto.

B. Furnish three (3) copies of operations and maintenance brochures, including spare parts list, at "Substantial Completion".

PART 2 - PRODUCTS

2.1 DUCT-FREE SPLIT SYSTEM FAN COIL UNITS

A. Furnish and install Duct-Free Split System Fan Coil Units as indicated and located on the Drawings. Equipment shall be of capacities, characteristics, sizes, etc., as indicated and scheduled on the Drawings, with the following features:

1. Microprocessor controls.
2. Self-diagnostics, including compressor drive, indoor fan, and reversing valve malfunction tests.
3. Restart function for automatic start after a power failure.
4. Automatic air sweep.
5. Mounting bracket and template.
6. 3-Speed fan motor.
7. Easy-to-remove cleanable filters; minimum one inch (1") thick
8. Accessories, as scheduled.
9. Electric heat strip, as applicable.
10. Wall mounted thermostat supplied by manufacturer. Non-wired hand-held remote not acceptable.
11. Built-in condensate pump with reservoir and sturdy high-low float switches and an overflow float switch to turn the A/C unit off. Separate external pump with separate 120/1 volt power requirement not allowed. Condensate pump shall be concealed in unit or in separate casing below unit matching unit casing type. Separate condensate pump using unit power shall be allowed if concealed in matching casing.

B. Units shall be as manufactured by:

1. Mitsubishi
2. Trane
3. Lennox
4. Carrier
5. Fujitsu.
6. LG.
7. Sanyo.

2.2 AIR COOLED HEAT PUMP

A. Furnish air cooled heat pump as scheduled. Brass service valves with refrigerant line fittings and service ports shall be located in the exterior of the unit. The unit shall be properly assembled and tested at the factory. It shall be designed for use with Refrigerant R-410A. Units shall be as manufactured and matched to the indoor unit.

B. Performance: Capacities shall be as scheduled, to be combination ratings for matched indoor coil and outdoor condensing unit installation shown including accounting for refrigerant line losses.

C. Condensing coils shall be made of copper tubes with aluminum fin construction and shall be warranted for 5 years. Coils shall have aluminum plate fins, mechanically bonded to the coil tubes. Coils shall be provided with the manufacturer's furnished, field or factory installed, condenser coil air inlet hail and vandal guards. Hardware cloth or flat expanded metal is not acceptable. Guards shall be baked enamel painted steel, PVC coated steel or other approved corrosion resistant metal.

D. Condenser Fans and Motors: Units shall be furnished with direct driven, propeller-type fans. Condenser fan motors shall have inherent protection, and shall be of the permanently lubricated type, resiliently mounted. Each fan shall have a corrosion resistant metal safety guard.

E. Compressor shall be of the welded-hermetic type with internal vibration isolation. Compressor motor shall have both thermal and current sensitive overload devices. Start assist (capacitor type) device shall

be standard on single phase units if the refrigerant piping is over 50 feet in total length. Compressor shall be equipped with a crankcase heater and have internal high pressure protection.

F. Controls and protective devices shall include a liquid line low- pressure switch, manual reset high pressure switch, suction line accumulator and pressure relief device. Control wiring terminal board shall be designed to match indoor unit terminal board and accessory thermostat terminals for standardized point-to-point connectors. An automatic defrost control shall be included to accomplish defrosting (only if coil saturated suction temperature indicated freezing temperatures) every 90 minutes for a period of not more than 10 minutes.

G. Accessories shall include Solid-State Time Guard, Liquid Line Filter Dryer, sight glass, Flare-To-Compatible Coupler, and a head pressure controller to allow operation down to 20 Deg.F. ambient temperature.

H. The air cooled heat pump shall carry the full one year parts and labor warranty on the entire unit, plus, an additional four year parts only warranty on the motor compressor unit.

I. All heat pumps shall have a minimum 15 SEER (ARI) at combination rating with matched DX-coil.

J. Units shall be as manufactured by:

1. Mitsubishi
2. Trane
3. Lennox
4. Carrier
5. Fujitsu.
6. LG.
7. Sanyo.

K. EXECUTION

2.3 DELIVERY AND PROTECTION

A. Deliver all equipment to each site. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost.

B. During construction, take all steps necessary to protect equipment from damage or vandalism. All damage or vandalism shall be repaired at no cost to the Owner.

2.4 AIR COOLED HEAT PUMP AND FAN COIL UNIT INSTALLATION

A. Install heat pump level on roof supports pads where shown with vibration pads.

B. Route refrigerant piping and make connections to DX coils as recommended by the unit manufacturer.

C. Furnish and install all refrigerant piping specialties including, but not limited to, thermal expansion valves, sight glasses, and filter dryers.

D. Furnish and install all factory furnished accessories not factory installed.

E. Charge all refrigerant piping systems and equipment to maintain a fully operating refrigerant charge.

F. Verify correct power and control wiring installation. Measure operating voltage and current, check proper rotation of motors, and verify correct settings of safety devices and controls.

G. Clean indoor and outdoor coils, including dust and lint, clean condensate pan on each fan coil unit section after the evaporator coil is clean.

H. Install new filters as specified in other sections of these specifications. Refer to Section 23 30 00.

2.5 REFRIGERATION PIPING

A. Piping shall be Type "K" copper, ACR cleaned and capped. All fittings shall be long radius and shall be cleaned and de-greased before use.

B. Refer to Section 23 23 00, Refrigerant Piping.

2.6 OPERATING PROCEDURES AND REQUIREMENTS

A. Operating and service instructions, three (3) copies, in illustrated and bound form shall be furnished by the manufacturer at "Substantial Completion".

B. At startup, the equipment manufacturer shall furnish skilled personnel to supervise, check out performance, make any required adjustments, place all units in service, and instruct the Owner's personnel for a full period of two (2) hours.

C. The manufacturer of each item of equipment shall provide complete wiring diagrams to the Electrical Contractor and shall provide drawings indicating all required external wiring and arrangements of connections.

2.7 WARRANTY

A. Transfer Warranty to Owner for a full one year period after "Substantial Completion".

B. Transfer any and all other warranties as applicable over to the Owner at "Substantial Completion", including extended 4-year compressor warranties, as applicable, on refrigeration equipment.

END OF SECTION

SECTION 23 82 46

HEAT GENERATION - ELECTRIC

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

B. Comply with all other Division 23 Sections as applicable. Refer to other Divisions for coordination of work with other trades.

1.2 SYSTEM DESCRIPTION

A. Scope of work shall include furnishing and installation of electric unit heaters, wall heaters, radiant heat panels and accessories as indicated and specified herein.

B. All items of equipment shall meet or exceed scheduled capacities and shall be provided in quantities indicated.

1.3 QUALITY ASSURANCE

A. All work shall comply with the most recent edition, with amendments of the local Building Code, Mechanical Code, Plumbing Code, Fire Code, and all other state and local codes or ordinances.

B. All heaters shall be Underwriters Laboratory (U.L.) listed and shall be listed for the specific installation application.

C. All equipment installations shall be installed in accordance with the National Electrical Code (NEC).

D. The manufacturer of each type of equipment specified herein shall have a minimum of five (5) years operating experience with each heater type.

1.4 SUBMITTALS

A. Indicate equipment, materials, quantities, sizes, installation details and any other descriptive literature necessary to fully evaluate submittals for compliance with these specifications.

B. Provide power supply and control wiring diagrams suitable for use by an electrician and control wiring technician.

C. Shop Drawings: Submit complete shop drawings in accordance with Division 1 and Section 23 05 00.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Damaged, deteriorated, or wet materials shall be rejected and replaced.

B. Take all measures necessary to protect equipment from damage or vandalism during construction. Any such damage discovered shall be cause for rejection of equipment, in which case the Contractor shall replace equipment at no cost to the Owner.

PART 2 - PRODUCTS

2.1 ELECTRIC UNIT HEATERS

A. Provide electric unit heaters which shall be complete packaged units with controls and accessories as specified herein to meet scheduled capacities as indicated on the Drawings.

B. Units shall be furnished with a minimum 18 gauge, die formed, steel cabinet with a factory applied phosphate coating and baked enamel paint finish.

C. Each unit shall have a direct drive fan motor with axial flow propeller blade fan. Fan motor shall be permanently lubricated with sealed bearings and internal overloads. Motor shall be the totally enclosed type rated for continuous heavy duty all angle operation and equipped with built-in thermal overload protection. Fan speed shall not exceed 1600 RPM.

D. Electric heating elements shall be low temperature enclosed style metal sheath type. Elements shall be made of steel and monel and have a copper clad steel sheath and aluminum fins warranted for five (5) years. Elements shall have automatic reset thermal overload protection to shut down elements and fan if safe operating temperatures are exceeded.

E. Units shall be provided with a control transformer to utilize a 24 volt control circuit with fan time delay control to purge unit of excess heat after unit shut down, and an automatic high limit cut-out. Motor contacts shall be provided on three-phase units and all units larger than 5.0 KW.

F. Units shall be furnished with wall mounting thermostat with Summer "Fan Only" switch, off switch, 65 Deg.F. to 90 Deg.F. range and heat position switch with number of stages to match scheduled heater.

G. Provide mounting brackets for ceiling suspension or wall swivel mount suitable for the applicable installation condition or as indicated on the Drawings. Provide minimum two point threaded hanger connection, mounting sockets, on suspended units over 100 pounds in weight. Provide four point connections on units over 200 pounds in weight.

H. Each unit shall be design-certified by Underwriters Laboratories and be UL listed and meet the requirements of the NEC.

I. Supply air shall be drawn and discharged through an outward drawn venturi. Provide individual, adjustable, horizontal discharge air louvers with 30 Degrees downward stops to prevent complete shut-off of air flow.

J. Heater shall be designed for a single electrical circuit, with elements, motor and control circuits subdivided with factory fuses to conform to the National Electric Code and Underwriter's Laboratory requirements. An access panel, with wiring diagram attached, shall be provided for access to electrical control circuiting and protective devices.

K. Acceptable manufacturers:

1. Reznor.
2. Trane.
3. Modine.
4. Emerson.
5. Q-Mark.
6. Markel.
7. BERKO

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to each site as indicated in Division 1.

B. All equipment shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt. All equipment shall be examined upon delivery to the site and evidence of abuse, damage, or exposure to weather and dirt shall be grounds for refusal to accept individual pieces of equipment. Rejected items shall be replaced promptly at no cost to the Owner.

C. Protect equipment during construction. Equipment damaged during construction prior to "Substantial Completion" shall be repaired or replaced at no cost to the Owner.

3.2 INSTALLATION

A. Install and wire electric heating equipment and field installed appurtenances in full accordance with the recommendations of the unit manufacturers and as indicated on the Drawings.

B. Provide power and control wiring as specified herein and as indicated on the Drawings.

C. Follow all national and local codes related to the wiring of electrical heating devices.

D. Verify correct installation and operation of each device installed.

END OF SECTION

SECTION 26 00 00

ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Division and all Electrical sections contained hereinafter are subject to the Contract Documents of Division 1 whether attached or not, the various Divisions of the General Construction specifications and Division 23 of the Construction specifications and respective plans.

B. All drawings, material in other Divisions of these specifications, addenda, and other pertinent documents are considered to be a part of the technical requirements of this Division of the specifications insofar as they are applicable.

C. The material contained in this section shall be applicable to other sections of the specifications under this Division.

1.2 DEFINITIONS

A. The following definitions shall apply to all sections of this Division:

1. "Owner" shall mean the Owner or his designated representative.

1.3 SCOPE OF WORK

A. This Division and all electrical sections of the specifications include all labor and material to complete all electrical systems as specified or shown on the Drawings.

B. All work shown and specified shall be completely installed and connected in a workmanlike manner by mechanics properly qualified to perform the work required. All work shall be left in a satisfactory operating condition as determined by the Owner.

C. Provide all services and perform all operations required in connection with or properly incidental to the construction of complete and fully operating systems with all accessories as herein specified or shown on the Drawings.

1.4 GENERAL

A. The accompanying plans show diagrammatically the location of the various light fixtures, devices, conduits and equipment items, and methods of connecting and controlling them. It is not intended to show every connection in detail or all fittings required for a complete system. The Contractor shall carefully lay out his work at the site to conform to the conditions, to avoid obstructions and provide proper routing of raceways. Exact locations of light fixtures, devices, equipment, and connections thereto shall be determined by reference to the accompanying Plans, etc., by field measurement at the project, and in cooperation with other Contractors and Sub-Contractors, and in all cases shall be subject to the approval of the Owner. Minor relocations necessitated by the conditions at the site or directed by the Owner shall be made without any additional cost to the Owner.

B. These specifications and the accompanying drawings are intended to describe and illustrate systems which will not interfere with the structures, which will fit into available spaces, and which will insure complete and satisfactorily operating installations. The Contractor shall be responsible for the proper fittings of his material and apparatus into the building and shall prepare installation drawings for all critical areas illustrating the installation of his work as related to the work of all other trades. Interferences with other trades or with the building structures shall be corrected by the Contractor before the work proceeds.

Should any changes become necessary due to failure to comply with these stipulations, the Contractor shall make such necessary changes at his own expense.

C. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted on the Drawings.

D. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide those details or special construction as well as to provide material and equipment usually furnished with such systems or required to complete the installation.

E. The Contractor, by submitting a bid on this work, sets forth that he has the necessary technical training and ability and that he will install his work in a satisfactory manner which is up to the best standards of the trade, complete and in good working order. If any of the requirements of the Drawings and Specifications are impossible to perform, or if the installation when made in accordance with such requirements will not perform satisfactorily, he shall report such occurrences to the Owner promptly after discovery of the discrepancy.

F. No extra compensation will be allowed for extra work or changes caused by failure to comply with the above requirements.

1.5 INSPECTION OF THE SITE

A. The Contractor shall visit the site, verifying all existing items indicated on the Drawings or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil, conditions, and local requirements. The submission of bids shall be deemed evidence of such visit.

B. All proposals shall take these existing conditions into consideration, and the lack of specific information on the Drawings shall not relieve the Contractor of any responsibility.

C. All site visits shall be coordinated and scheduled with the Owner.

1.6 CODE REQUIREMENTS

A. All work shall comply with the provisions of these specifications, as illustrated on the accompanying drawings, or as directed by the Architect, and shall satisfy all applicable local codes, ordinances, or regulations of the governing bodies, and all authorities having jurisdiction over the work, or services thereto. In all cases where alterations to, or deviations from, the drawings and specifications are required by the authority having jurisdiction, report the same in writing to the Architect and secure his approval before proceeding. Upon completion of the work, furnish a statement from the inspecting authority stating that the installation has been accepted and approved. Provide complete utility service connections as directed, and submit, as required, all necessary drawings; secure all permits and inspections necessary in connection with the work, and pay all legal fees on account thereof. In the absence of other applicable local codes acceptable to the Architect, the National Electrical Code shall apply to this work.

1.7 RECORD DRAWINGS

A. The Contractor shall, during the execution of the work, maintain a complete set of drawings upon which all locations of equipment, panels, and all deviations and/or changes in the work shall be recorded. All underground and overhead utilities provided under, or affected by, work of this Division shall be accurately located by dimensions. These "Record" drawings shall be delivered to the Architect in good condition upon the completion and acceptance of the work and before final payment is made.

1. Refer to Division 1 requirements.

1.8 RECORDS AND INSTRUCTIONS FOR OWNER

A. The Contractor shall accumulate, during the project's progress, the following sets, prepared in neat brochures or packet folders and turned over to the Architect for checking and subsequent delivery to the Owner:

1. All warranties and guarantees and manufacturer's directions on equipment and material covered by the Contractor.
2. Approved equipment brochures, wiring diagrams and control diagrams.
3. Copies of reviewed Shop Drawings.
4. Operating instructions for all systems. Operating instructions shall include recommended maintenance procedures.
5. Any and all other data and drawings required during construction.
6. Repair parts lists of all major items and equipment including name, address, and telephone number of local supplier or agent.

B. All of the above data shall be submitted to the Architect for review at such time as the Contractor makes application for final payment, but in no case less than two weeks before final observation.

C. The Contractor shall also give not less than two (2) days of operating instructions, during the adjustment and testing period, to the Owner's operating personnel in order to familiarize them with the proper care and operation of the equipment. The written operating instructions referred to in above paragraphs shall be used as a basis for this on-the-job instruction.

1. Refer to Division 1 requirements.

1.9 SHOP DRAWINGS AND SUBMITTALS

A. The Contractor shall submit, to the Architect, shop drawings and catalog data on all equipment and materials designated on the Drawings and specified herein.

B. The submittal will be reviewed for compliance with general requirements of design and arrangement only; it is not a contract document and acknowledgement of compliance does not relieve the Contractor from responsibility for performance of the work in compliance with all provisions and requirements of the Contract Documents. Job measurements and the coordination of all the dimensions for proper fit of all parts of the work and performance of all equipment supplies to meet specification requirements are and remain specific responsibilities of the Contractor.

C. Shop Drawings shall be furnished by the Contractor for the work involved after receiving approval on the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job, and failure on the part of the Contractor to comply shall render him liable to stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary detailed drawings. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary, and should there be any charges in connection with this, they shall be borne by the Contractor.

D. The Shop Drawings submitted shall not consist of manufacturers' catalogues or tear sheet therefrom that contain no indication of the exact item offered. Rather, the submission on individual items shall designate the exact item offered.

E. Shop Drawings submitted without indicating markings or Contractor's stamp shall not be reviewed and will be returned to the Contractor for correction of such discrepancies.

F. The Shop Drawings are not intended to cover detailed quantitative lists of electrical specialties, and similar items, as the plans and specifications illustrate and describe those items, and it is the Contractor's responsibility to procure the proper sizes and quantities required to comply with the established requirements.

G. Any Shop Drawings prepared to illustrate how equipment can be fitted into available spaces will be examined under the assumption that the Contractor has verified all the conditions, and obtained any approval thereon shall not relieve the Contractor of responsibility in the event the material cannot be installed as shown on those Drawings.

H. Various material submissions of such as raceways, switches, panelboards, and related items shall be assembled in brochures or in other suitable package form and shall not be submitted in a multiplicity of loose sheets.

I. Each Contractor shall process his submitted data to insure that it conforms to the requirements of the plans and specifications and that there are no omissions, errors or duplications.

J. Shop Drawings shall be accompanied by certification from this Contractor that Shop Drawings have been checked by him for compliance with Contract Drawings.

K. Samples of various products or mock-ups of particular details or systems may be required by various sections of this Specification.

L. Refer to Division 1 requirements.

1.10 PENETRATIONS THROUGH FIRE-RATED ASSEMBLIES

A. Seal voids around ducts and pipes penetrating fire-rated assemblies and partitions using fire-stopping materials and methods in accordance with provisions in Division 1.

1.11 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. All equipment furnished under other Divisions of the specification requiring service connections shall be connected by this Contractor. Materials and labor required for the connection of this equipment shall be furnished under Division 26. The respective supplier shall furnish proper roughing-in diagrams for the installation of these items. All items shall be roughed-in and connected in strict accordance therewith. All equipment requiring connection may not be specified herein, but may be included in other Division documents. This Contractor shall ascertain for himself all equipment so specified is included as part of his work.

B. Refer to Section 26 05 23.

1.12 DRAWINGS

A. The drawings show diagrammatically the locations of the various conduits, fixtures, and equipment, and the method of connecting and controlling them. It is not intended to show every connection in detail and all fittings required for a complete system. The systems shall include, but are not limited to, the items shown on the drawings. Exact locations of these items shall be determined by reference to the general plans and measurements at the building and in cooperation with other trades and, in all cases, shall be subject to the approval of the Architect. The Architect reserves the right to make any reasonable change in the location of any of this work without additional cost to the Owner.

B. Should any changes be deemed necessary in items shown on the contract drawings, the shop drawings, descriptions, and the reason for the proposed changes shall be submitted to the Architect for approval.

C. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention before bids are submitted; otherwise, the Contractor shall be responsible for the cost of any and all changes and additions that may be necessary to accommodate his particular apparatus.

D. Lay out all work maintaining all lines, grades, and dimensions according to these drawings with due consideration for other trades and verify all dimensions at the site prior to any fabrication or installation; should any conflict develop or installation be impractical, the Architect shall be notified before any

installation or fabrication and the existing conditions shall be investigated and proper changes effected without any additional cost.

E. Titles of Sections and Paragraphs in these specifications are introduced merely for convenience and are not to be construed as a correct or complete segregation or tabulation of the various units of material and/or work. The Architect does not assume any responsibility, either direct or implied, for omissions or duplications by the Contractor due to real or alleged error in the arrangement of matter in the Contract Documents.

1.13 COOPERATION

A. All work under these specifications shall be accomplished in conjunction with other trades on this project in a manner which will allow each trade adequate time at the proper stage of construction to fulfill his work.

B. Maintaining contact and being familiar with the progress of the general construction and the timely installation of sleeves and inserts, etc., before concrete is placed shall be the responsibility of this trade as will the installation of the required systems in their several stages, at the proper time to expedite this contract and avoid unnecessary delays in the progress of other contracts.

C. Should any question arise between trades as to the placing of lines, ducts, conduits, or equipment, or should it appear desirable to remove any general construction which would affect the appearance or strength of the structure, reference shall be made to the Architect for instructions.

1.14 MATERIALS AND EQUIPMENT

A. All materials purchased for this Project shall be new.

B. Where specified product is not manufactured, manufacturer's current product meeting specification shall be substituted, subject to written approval of Engineer.

C. Space allocations in electrical spaces are based on equipment scheduled in each case. Should the Contractor offer equipment of another make, he shall verify that such equipment will fit in the spaces allowed.

D. Manufacturers' names are listed herein to establish a standard. The products of other manufacturers will be acceptable; if, in the opinion of the Architect, the substitute material is of a quality as good or better than the material specified, and will serve with equal efficiency and dependability, the purpose for which the items specified were intended.

E. It is fully the Contractor's responsibility to assemble and submit sufficient technical information to fully illustrate that the material or equipment proposed for substitution is equal or superior as the Architect or his Engineer is under no obligation to perform the service for the Contractor. The proposal shall be accompanied by manufacturers' engineering data, specification sheet, and a sample, if practical or if requested. In no event shall a proposal for substitution be cause for delay of work.

F. Should a substitution be accepted under the above provisions, and should the substitution prove defective or otherwise unsatisfactory for the intended service, within the warranty period, the Contractor shall replace the substitution with the equipment or material specified, and on which the specifications required him to base his proposal.

1.15 STORAGE AND PROTECTION OF MATERIALS

A. The Contractor shall provide his own storage space for protection and storage of his materials and assume complete responsibility for all losses due to any cause whatsoever. All storage shall be within the property lines of the building site, or as directed by the Owner's representative. In no case shall storage interfere with traffic conditions in any public or project thoroughfare.

B. All work and material shall be protected at all times. This Contractor shall make good any damage caused, either directly or indirectly, by his workmen. He shall be responsible for safe handling of all electrical equipment and shall replace, without charge, all items damaged prior to acceptance by the Owner.

1.16 FOUNDATIONS

A. Provide bases and foundations for all equipment specified or shown, unless specifically noted to the contrary. Foundations are generally to be built in compliance with the equipment manufacturer's shop drawings which have been approved by the Architect, or as directed by the Architect. Vibration or noise created in any part of the building by the operation of any equipment furnished or installed under this portion of the work will be objectionable. Take all precautions against same by isolating the various items of equipment from the building's structure, and by such other means as may be necessary to eliminate all excessive vibration and objectionable noise produced by any equipment installed; install all foundations, supports, etc., for raceway system and equipment with this end in view.

1.17 EXCAVATION AND BACKFILLING

A. The Contractor shall do all necessary excavating and backfilling for the installation of his work. Trenches for underground conduits shall be excavated to required depths with bell holes provided as necessary to insure uniform bearing. Care shall be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where rock or hard objects are encountered, they shall be excavated to a grade six inches (6") below the lowermost part of the conduit and refilled to grade as specified. After the conduit has been installed and approved, the trenches shall be backfilled to grade with approved materials, well tamped or puddled compactly in place. Where streets, sidewalks, etc., are disturbed, cut, or damaged by this work, the expense of repairing same in a manner approved by the Architect shall be a part of this contract.

1.18 SCHEDULE OF WORK

A. The work under the various sections must be expedited and close coordination will be required in execution of the work. The various Contractors shall perform their work at such times as directed so as to insure meeting scheduled completion dates, and to avoid delaying any other Contractor. The Architect will set up completion dates, schedule the times of work in the various areas involved, etc. This Contractor shall cooperate in establishing these times and locations and shall process his work so as to insure the proper execution of it.

1.19 COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. The Contractor shall provide qualified personnel, as requested by the Owner and Architect, to assist in all on-site testing and commissioning of all equipment.

1.20 CLEANING UP

A. The Contractor shall be responsible for cleaning up his work as specified in the General Requirements of these Specifications.

1.21 FINAL OBSERVATION

A. Schedule: Upon completion of the Contract, there shall be a final observation of the completed installation. Prior to this observation, all work under this Division shall have been completed, tested, and balanced and adjusted in final operating condition and the test report shall have been submitted to and approved by the Owner.

B. Qualified personnel representing the Contractor must be present during final observation to demonstrate the systems and prove the performance of the equipment.

1.22 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these Specifications.

B. Furnish, at the completion of the job, a final Inspection Certificate from the local inspecting authority.

1.23 GUARANTEE

A. The guarantee provision of this specification requires prompt replacement of all defective workmanship and materials occurring within one year of final job acceptance. This includes all work required to remove and replace the defective item and to make all necessary adjustments to restore the entire installation to its original specified operating condition and finish at the time of acceptance. The Contractor shall also guarantee that the performance of all equipment furnished and/or installed under this Division of the specifications shall be at least equal to the performance as called for in the specifications and as stated in the equipment submittals. Should there be indication that the equipment and installation is not producing the intended conditions, the Contractor shall make further tests as the Engineer may direct to demonstrate that the equipment installed meets the specifications. If there is indication that the equipment does not meet the specifications, the Contractor shall, at his expense, institute a program to demonstrate the adequacy of the installation. This program shall include all necessary testing and testing equipment. Should the Contractor not have the equipment or technical skill to perform the tests, it shall be his responsibility to provide recognized experts to perform the tests and shall provide certified laboratory tests, certified factory reports and work sheets, or other certified data to support results of any tests required.

B. Refer to Division 1 requirements.

PART 2 - PRODUCTS

NOT USED

PART 3 - INSTALLATION

3.1 DEVICE MOUNTING REQUIREMENTS

A. Mounting heights listed in Drawings shall be defined as measured from the centerline of the device or outlet box to finished floor elevation. Unless specifically noted otherwise on the Drawings. Device heights shall be in accordance with the Texas Accessibility Standards or the Americans with Disabilities Act.

B. Where devices are grouped together, they shall be mounted at the same height.

C. Coordinate all mounting dimensions with Owner's requirements and coordinate with architectural elevations and details.

3.2 HOUSEKEEPING PADS

A. Provide 4 inch thick concrete housekeeping pad with 6 x 6 wire mesh and same cure strength as adjacent floor for all floor-mounted electrical equipment unless otherwise indicated on the Drawings. Provide dowel connections to floor if pad is not part of continuous floor pour.

1. Provide inserts for anchor bolts as required for each floor-mounted piece of electrical equipment.
2. Provide 3/4 inch chamfered edge at all exposed edges.

B. Minimum pad dimensions shall be 6 inches greater than dimensions, including all protrusions, of equipment to be installed.

1. Free-standing equipment: Center equipment on housekeeping pad.
2. Equipment anchored to wall: Center equipment side-to-side on housekeeping pad and reduce pad front-to-back dimension by 3 inches.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Provide systems of wires and cables for electric power, signaling and control.

B. Related work specified in other sections

1. 26 00 00 - Electrical
2. 26 05 20 - Cable Connections
3. 26 05 23 - Control Voltage Electrical Power Cables
4. 26 05 32 - Raceways
5. 26 05 33 - Raceway and Boxes for Electrical Systems

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. ICEA 5-61-402 Thermoplastic Insulated Wire and Cable

B. ICEA 5-66-524 Cross Linked Thermosetting Polyethylene Insulated Wires and Cables

C. ICEA 5-68-516 Ethylene Propylene Rubber Insulated Wire and Cable

D. ICEA 5-19-81 Rubber Insulated Wire and Cable

E. ANSI 1581 Standard of Electrical Wires, Cables, and Flexible Cords.

F. UL 83 Thermoplastic Insulated Wires and Cables

G. UL 1569 Metal Clad Cables

H. ASTM B3 Standard Specification for Soft or annealed Copper Wire

I. ASTM B8 Standard Specification for Concentric Lay Standard Copper Conductors

1.5 SUBMITTALS

A. Where products are of a manufacturer other than listed as acceptable manufacturers, submit manufacturer’s product literature completely describing conductors and cable assembles and evidence of U.L. Listing.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver conductors and cable assemblies to the project in the manufacturer's standard reels or boxes marked with conductor material, insulation type, conductor size and U.L. Label.

B. Store conductors and cable assemblies in a clean, dry location to prevent damage from moisture, dust, personnel and equipment.

C. Handle conductors and cables in a manner to prevent damage to conductor, insulation, jackets, and identifying markings.

1.7 MANUFACTURERS

A. The material shall be the product of a manufacturer with a minimum of ten years experience in the manufacture of similar material.

B. Acceptable Manufacturers:

1. AFC Cable Systems.
2. Cerro Wire, Inc.
3. General Cable
4. Southwire Company
5. Okonite Company

1.8 WARRANTY

A. The material shall be warranted to be free from defect and in proper working order for one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Copper Conductors

1. Conductors shall be copper unless specifically noted otherwise on the Drawings.
2. Copper conductors shall be soft drawn annealed copper, minimum conductivity 98% of pure copper per ASTM ASTM-B3.
3. Sizes No. 10 AWG and smaller shall be solid conductor, single strand.
4. Sizes No. 8 AWG and larger shall be concentric lay Class B stranding.
5. Shall conform to the Conductor Properties proscribed in the NEC.

B. Insulation

1. Type THWN: 600 volt moisture and heat resistant thermoplastic rated 75 Deg.C. in wet or dry.
2. Type THWN-2: 600 volt moisture and heat resistant thermoplastic rated 90 Deg.C. in wet or dry locations.
3. Type XHHW: 600 volt moisture resistant cross linked polyethylene rated 75 Deg.C. in wet or dry locations.
4. Type XHHW-2: 600 volt moisture resistant cross linked polyethylene rated 90 Deg.C. in wet or dry locations.

C. Cable Assemblies:

1. Type UF: 600 volt moisture and heat resistant, rated 75 Deg.C. for wet, dry or underground direct burial installations.
2. Type MC Branch Circuit Cable: 600 volt, Type THHN/THWN conductors size 12 AWG through 10 AWG, including a green insulated grounding conductor, with steel interlocked armor applied over the assembly.

PART 3 - EXECUTION

3.1 USES PERMITTED

A. Unless specifically noted on the drawings, permitted by the NEC and local codes and ordinances, wiring shall be Types THWN-2 or XHHW-2 installed in metal raceways as specified in 26 05 32, Raceways.

B. For final connections from junction boxes mounted on the building structure to recessed lighting fixtures. Type MC cable assemblies shall be permitted, with the cable assembly length not to exceed six feet and with supports as required by the NEC. Fixture-to-fixture chain wiring is not permitted.

3.2 COLOR CODING

A. Where available, insulation shall be color coded by factory pigmentation for each phase and each voltage system employed on the project.

B. 120/208 volt systems:

1. Phase A - Black
2. Phase B - Red
3. Phase C - Blue
4. Neutral - White
5. Ground - Green

C. 277/480 volt systems:

1. Phase A - Brown
2. Phase B - Orange
3. Phase C - Yellow
4. Neutral - Gray
5. Ground - Green

D. Switch legs, travelers and special systems shall be continuous color scheme throughout the project as selected by the Contractor.

E. Where factory pigmentation is not available, code conductors with 1-1/2" colored tape band at each terminal and at each pull or junction box.

3.3 GROUNDING CONDUCTORS

A. All branch circuits and feeders shall include an insulated equipment grounding conductor. Raceway systems shall not be used as the sole equipment grounding path without specific approval.

3.4 MULTIWIRE BRANCH CIRCUITS

A. Multiwire branch circuits shall not be permitted unless required by the device served, such as for connection to modular furniture systems or track lighting systems.

B. Where multiwire branch circuits are required, branch circuit breakers shall be two or three pole with common trip and one handle.

3.5 MINIMUM SIZE

A. Conductors shall be of the minimum size shown on the drawings, lighting and power branch circuit wiring shall be minimum No.12 AWG.

B. Feeder circuit wiring shall be sized to limit the effect of voltage drop, based on the actual installed conductor length to limit voltage drop to 2% of nominal system voltage.

C. Branch circuit wiring shall be size to limit the effect of voltage drop, based on the actual installed conductor length, to limit voltage drop to 3% or less of nominal system voltage.

D. Circuits shall be grouped in raceways and grouped together when passing through enclosures to have phases and neutral grouped together to minimize circuit reactance.

3.6 INSTALLATION

A. Examine the system in which the conductors are to be installed for defects in equipment and installation which may cause damage to the conductors, insulation, or jackets.

B. Pull a swab or mandrel through conduit systems immediately before pulling conductors to insure a full bore, clean raceway system.

C. Do not exceed the conductor manufacturer’s maximum pulling force or minimum bending radius.

D. Use pulling lubricant compound where necessary and recommended by the manufacturer.

E. Conductors or cables which have insulation or jackets damaged in the pulling process shall be removed and replace with new material.

3.7 FIELD QUALITY CONTROL

A. Test all wiring insulation with a megohm meter prior to energization:

1. Phase to ground
2. Phase to phase
3. Phase to neutral
4. Neutral to ground

B. Perform test in accordance with manufacturer’s recommendation and to meet manufacturer’s published minimum insulation values.

C. Correct all defects revealed by such tests including replacing material with new as required.

END OF SECTION

SECTION 26 05 20

CABLE CONNECTIONS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1- General Requirements and related documents.

B. All sections of this Specification.

1.2 DESCRIPTION

A. Work Included: Provide wire connections and devices to be readily identifiable, mechanically and electrically secure wiring system.

B. Related work specified in other sections:

1. 26 05 19 Low Voltage Electrical Power Conductors and Cables

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 SUBMITTALS

A. Samples: Provide samples upon specific request.

B. Product Data: If materials are by manufacturers other than those specified, submit product data giving complete description for sizes employed, material types, and electrical ratings.

1.5 DELIVERY, STORAGE AND HANDLING

A. Connections shall be made in atmospheres that are free from dirt, moisture, and elements which may be damaging.

1.6 MANUFACTURERS

A. The materials shall be the product of a manufacturer with a minimum ten years experience in the manufacture of similar materials.

B. Acceptable manufacturers are listed with the products.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Spring Connectors: Ideal "Wingnut" 3M-Scotch, Buchanan, and Thomas and Betts.

B. Terminal Connectors: O-Z/Gedney, Burndy, and Thomas and Betts.

C. Splice Connectors: O-Z/Gedney or Burndy with insulating cover.

D. "T" and Parallel Connectors: O-Z/Gedney or Burndy with insulating cover.

E. Vinyl Plastic Tape: 3M-Scotch #33 or #88, Plymouth and Okonite.

F. Rubber Tape: Okonite, 3M-Scotch and Plymouth.

G. Colored Tape: 3M-Scotch, Plymouth.

H. Wire Ties: Thomas and Betts "Ty-Rap", Ideal and Panduit.

I. Tie Mounts, Plates, Anchors: Thomas and Betts, Ideal, and Panduit.

J. Wire Tags: Self-laminating, cloth, wrap-on type by Thomas and Betts, Ideal, and Brady.

K. Terminal Strips: Nylon; 600 volt; modular plug-on construction; tubular compression slip-in terminals properly sized; complete with mounting track, end clips, and anchors by Allen-Bradley, Square D, and Buchanan.

L. Cable and Cord Fittings: Crouse-Hinds with wire mesh grip or Appleton.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine wires to be joined, tapped, spliced, terminated, and their connecting devices for defects which may affect the mechanical and electrical integrity of the connection.

B. Do not proceed until defects are corrected.

3.2 PREPARATION

A. Remove proper amount of insulation necessary for connection, clean conductors.

3.3 INSTALLATION

A. No. 10 Wire and Smaller: Connect with spring connectors, terminate at terminal strips.

B. No. 8 Wire and Larger: Connect and terminate with above specified tape half-lapped to produce a dielectric value equal to wire insulation.

C. Train, hold, clamp, and tag wiring in cabinets, pull boxes, panels, and junction boxes with above specified devices.

D. Splices in feeders and mains may only be made where designated on the drawings and where prior approval is obtained from the Architect.

E. Install terminal strips in enclosures without means for termination of wiring.

F. Install cable and cord grips on all cables and cords, entering enclosures. Use wire mesh grips where necessary for strain relief.

3.4 FIELD QUALITY CONTROL

A. Test: Connections shall be resistance tested with megohm meter as specified for wire.

3.5 ADJUSTMENTS

A. Assure that wire connections made by others in equipment furnished by others are mechanically and electrically sound prior to energization.

END OF SECTION

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SECTION 26 05 23

CONTROL - VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included: Provide power wiring, raceways, and connections for items of equipment and control systems.

B. All wiring for every system shall be installed in metal conduit. Refer to Section 26 05 32 Raceways for conduit types and materials for specific locations and applications.

C. Related work specified in other sections:

1. 23 09 00 Instrumentation and Controls for HVAC
2. 26 00 00 Electrical
3. 26 05 19 Low Voltage Electrical Power Conductors and Cables
4. 26 05 32 Raceways
5. 26 28 16 Enclosed Switches and Circuit Breakers
6. 28 31 00 Fire Alarm System

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 WARRANTY

A. The material shall be warranted to be free from defect and in proper working order for one year following the date of final acceptance.

1.5 COORDINATION

A. For equipment furnished under other Divisions, obtain equipment supply and wiring requirements from the Contractor supplying the equipment.

B. For equipment furnished under Division 23, obtain complete temperature control system drawings, and power supply and interlock wiring requirements from the Contractor furnishing the systems.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to related work specified in other sections for material requirements.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Work Included: The Electrical Contractor shall provide:

1. Branch circuit and motor feeder circuit conductors, raceway, connections, and overcurrent protection for each motor or item of equipment furnished by the Owner or other Contractors.
2. Installation of motor controllers furnished by the Owner or other Contractors, along with branch circuit and motor feeder circuit conductors, raceway, and connections in accordance with the manufacturer's approved wiring diagrams.
3. Disconnect switches and combination disconnect switches and motor controllers, where indicated on the drawings or required by codes, except as provided as an integral part of manufactured equipment.
4. Power supply conductors, raceway, connections, and overcurrent protection for input power to HVAC Temperature Controls, HVAC Automation, and HVAC Energy Management Systems in accordance with approved rough-in and connection diagrams furnished by the system suppliers.
5. The above represents an outline of the work for the purpose of describing one division of the work which is acceptable to insure that all work is contained within the General Contract. Nothing herein shall be construed to confine the General Contractor from assigning the work to any member or group of contractors deemed best suited to executing the work to effect the contract. Refer to specific bidding instructions of the General Contractor for the actual division of the work. The General Contractor is fully responsible for the installation of complete, operating systems in accordance with the functional intent of the specifications.

B. Work Not Included: The Mechanical Contractor shall provide:

1. Motors and equipment, erected in place and ready for final connection of power supply wiring, along with manufacturer's approved wiring diagrams.
2. Motor controllers, in suitable enclosures and of the type and size in accordance with the manufacturer's recommendations and NEMA requirements, along with properly sized overload elements and approved wiring diagrams.
3. Disconnecting switches or devices which are normally provided as a part of manufactured equipment.
4. Rough-in and connection diagrams for input power supply and connections for the HVAC Temperature Control, HVAC Automation, and HVAC Energy Management Systems.
5. Conductors, raceways, devices, and connections for low voltage control, line voltage control, and signaling systems for the HVAC Temperature Control, HVAC Automation, and HVAC Energy Management Systems in accordance with the provisions of Division 26, and approved systems shop drawings to provide complete operating systems in accordance with the functional requirements of the specifications.
6. The above represents an outline of the work for the purpose of describing one division of the work which is acceptable to insure that all work is contained within the General Contract. Nothing herein shall be construed to confine the General Contractor from assigning the work to any member or group of contractors deemed best suited to executing the work to effect the contract. Refer the specific bidding instructions of the General Contractor for the actual division of work. The General Contractor is fully responsible for the installation of complete, operating systems in accordance with the functional intent of the specifications.

C. Completely connect all electrical consuming items of mechanical equipment, kitchen equipment, shop equipment, etc., provided by the Owner or other trades. Outlets of various types have been indicated at equipment locations, but no indications or exact location or scope of work is indicated on the accompanying drawings.

D. Refer to details and information furnished by the Owner and various equipment suppliers for equipment wiring requirements and to the Plumbing and Heating, Ventilating and Air Conditioning Specifications for the scope of the connections to equipment provided under those sections, and determine from the various trades by actual measurements at the site, and by direction from the Owner and the Architect the exact locations of all items. Roughing-in drawings, wiring diagrams, etc., required for the proper installation of the electrical work will be furnished by applicable trades furnishing equipment. Request the drawings and information required in writing to the equipment supplier in ample time to permit preparation of the

drawings and to permit proper installation of all wiring. Obtain from those furnishing equipment the size and type of service required for each motor or piece of electrical equipment and verify that the service to be installed is compatible.

3.2 INSTALLATION

A. All conduits shall terminate in conduit boxes on motors where possible. When motors are direct-connected, the conduit may continue rigid into the box, but when motors drive through belts and have sliding bases, a piece of flexible liquid tight conduit not less than 12 inches long shall be connected between the rigid conduit and the motor terminal. Where motors are not provided with conduit boxes, terminate the conduit in a condulet at the motor.

B. Where disconnecting switches are not provided integral with the control equipment for motors, provide and install a disconnect switch in the circuit to each motor where indicated and required by code. Switches shall be installed as close as possible to the motor or controls they serve and they shall be within sight of the motor or control circuit.

C. Be responsible for installing all conductors and protective devices serving equipment motors furnished by others in strict conformance with all applicable codes, regardless of any discrepancy in plans and/or mechanical equipment sizes variations, unless covered by directives issued by the Architect.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Provide a grounding electrode for the facility and a ground electrode conductor system to connect to the electric service main equipment.

B. Provide supplementary grounding electrodes as specified herein.

1. Provide connections from the grounding electrode system to:
2. The electric power system grounded circuit conductor (neutral).
3. The electric power system non-current carrying enclosures and equipment ground conductors (equipment ground).

C. Provide connections from the grounding electrode system to auxiliary ground conductors for data and voice communication systems (isolated ground).

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. National Electrical Code, NFPA 70.

B. EIA/TIA Standard 607

C. IEEE - Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

D. IEEE Standard 81 - Guide for Measuring Earth Resistivity.

1.5 SUBMITTALS

A. Where products are of a manufacturer other than listed as acceptable manufacturers, submit manufacturer’s product literature completely describing conductors and cable assembles and evidence of U.L. Listing.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver conductors and cable assemblies to the project in the manufacturer’s standard reels or boxes marked with conductor material, insulation type, conductor size and U.L. Label.

B. Store conductors and cable assemblies in a clean, dry location to prevent damage from moisture, dust, personnel and equipment.

C. Handle conductors and cables in a manner to prevent damage to conductor, insulation, jackets, and identifying markings.

1.7 MANUFACTURERS

A. The materials shall be the products of a manufacturer with a minimum of ten years experience in the manufacture of similar material.

B. Acceptable manufacturers shall be as listed with the material descriptions.

1.8 WARRANTY

A. The material shall be warranted to be free from defect and in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 GROUND RODS

A. Standard ground rods shall be 3/4 inch diameter, 10 foot length, copper clad steel, equal to Thompson Company.

2.2 CONDUCTORS

A. Conductors buried in contact with the earth shall be bare copper, solid for sizes up to No. 6 AWG, concentric lay strand for sizes No. 8 AWG and larger.

B. All other grounding conductors shall be copper conductor, Type THWN 600 volt 90 Deg.C. thermoplastic insulation, green color where available.

2.3 CONNECTIONS

A. All connections made below grade, in inaccessible locations, and all connections and splices in the grounding electrode conductor system shall be made by exothermic weld process equal to Cadweld. Provide polyethylene inspection well covers and lids equal to Erico #T416B.

B. All other connections shall be hydraulically crimped irreversible connectors equal to Thomas and Betts 54000 Series.

C. Connections to cable trays shall be Thomas and Betts 10105 malleable iron mechanical clamp.

D. Connections to domestic cold water piping shall be Thomas and Betts GUV Series copper alloy U-bolt and mechanical clamp.

E. Connections to building structural steel shall be exothermic weld equal to Cadweld.

F. Connections which require flexibility for movement, expansion, or vibration shall be made with flexible flat conductor, multiple strands of 30 gauge copper conductors or equivalent circular mil area to the primary ground conductor. Protect ends with copper bolt hole end pieces.

2.4 CONDUITS

A. Provide malleable iron conduit grounding bushings where:

1. Metallic raceways terminate at metal housings without mechanical and electrical connection to housing.
2. At each end of metallic conductors for grounding conductors where conduits are electrically non-continuous.
3. At the ends of service entrance conduit.

PART 3 - EXECUTION

3.1 GROUNDING ELECTRODE

A. Provide one, or more, driven solid ground rods to serve as the grounding electrode for the facility. Additional rods shall be driven at not less than ten foot separation and connected together until the specified resistance testing criteria can be met.

B. Grounding electrode shall be tested and certified to provide five ohms or less Earth resistivity.

3.2 SUPPLEMENTARY GROUND ELECTRODES

A. The following items, where they exist on the project, shall be bonded together with the main grounding electrode described above:

1. Domestic cold water service entrance.
2. Building structural steel frame.
3. Minimum twenty feet of bare copper conductor, minimum No. 4 AWG, encased in a concrete footing along the exterior perimeter edge of the building.

B. Ground Electrode Bus:

1. Provide a single copper bus bar located adjacent to the service main disconnecting means as the common connection point for the main ground electrode and each supplementary ground electrode.
2. Mount ground bus on suitable wall insulator stand-offs.
3. All grounding electrode conductors shall be permanently connected to this bus with exothermic weld connections.
4. All grounding electrode conductors shall be the same size and shall be not less than the size required by NEC or the size shown on the Drawings.
5. Connect the grounding electrode system to the main ground connection in the U.L. Listed Service Disconnecting means in the main switch or switchboard.

3.3 GROUNDED CIRCUIT CONDUCTOR

A. Bond the grounding electrode system to the grounded circuit conductor (neutral conductor) at one location only, on the supply side of the service disconnecting means, with a neutral disconnecting link as required by the NEC.

3.4 EQUIPMENT GROUNDING CONDUCTORS

A. Bond the non-current carrying parts of the electric power system to the grounding electrode conductor at the service disconnecting means. From this point forward, all non-current carrying parts of the electric power system shall be electrically connected and continuous by means of:

1. Electrically continuous equipment enclosures, metallic boxes and metallic raceways connected with U.L. Listed connectors and couplings.
2. Equipment grounding conductors supplementary to metallic raceway systems where shown on the Drawings.
3. Equipment grounding conductors in non-metallic raceway systems and in flexible metal conduit systems.
4. Where permitted under other sections of the Specification, the insulated grounding conductor provided in Type MC cable will be considered an acceptable equipment grounding conductor.
5. Uninsulated grounding strips and spiral wrap provided in Type AC cable is not an acceptable grounding conductor.

3.5 ISOLATED GROUND SYSTEMS

A. Wiring Devices:

1. Where specifically shown on the Drawings, isolated ground wiring devices may be employed. Where these devices are used, a separate insulated isolated ground conductor shall be provided in the branch circuit wiring, in addition to the equipment grounding conductors described above.
2. Provide isolated ground bus in panelboards which supply branch circuits to isolated ground devices. Isolated ground busses shall be electrically insulated from the panelboard equipment enclosure.
3. Provide an insulated conductor as a bonding jumper inside the panelboard to connect the isolated ground buss to the equipment ground buss in the panelboard. Bonding jumper shall be a minimum of the same size as the equipment grounding conductor for the panelboard feeder, or the size shown on the Drawings.

B. Isolated Ground Systems:

1. Provide auxiliary isolated ground systems as shown on the Drawings for the grounding of specific voice, data, communication systems and for single point reference ground of separately derived systems.
2. These systems shall be extensions of the Grounding Electrode System by means of radial isolated ground conductors from the main ground electrode bus to secondary ground electrode busses located throughout the facility.
3. These systems shall remain insulated from equipment enclosures raceway systems that are a part of the equipment grounding system.

3.6 SEPARATELY DERIVED SYSTEMS

A. Separately derived systems include:

1. Secondaries of dry type power transformer.
2. Outputs of uninterruptible power systems.
3. Outputs of motor generator sets or frequency convertors.

B. These systems shall be grounded in accordance with the NEC, similar to the service disconnecting means discussed above, and as shown on the Drawings.

C. The grounding electrode conductor from a separately derived system shall be connected to the main ground electrode bus described above, or to one of the secondary ground electrode busses, if present.

D. A second grounding electrode conductor shall connect to building structural steel frame at the nearest available location, if available.

3.7 TESTING

A. Grounding Electrode:

1. The earth resistance of the main ground electrode shall be not more than 5 ohms.
2. Perform a measurement of ground resistance by one of the means described in IEEE Standard 81, Guide for Measuring Earth Resistivity.
3. Provide written certification of the ground resistance measurements upon request.

B. Grounding Continuity:

1. Provide continuity tests and checks of equipment grounding and isolated grounding conductor systems to insure electrical continuity.
2. Provide written certification of continuity checks upon requests.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1- General Requirements and related documents.

B. All sections of this Specification.

1.2 DESCRIPTION

A. Work Included: Provide miscellaneous materials for the supporting of electrical material and equipment.

B. Related work specified in other sections:

1. 26 00 00 Electrical
2. 26 05 32 Raceways
3. 26 27 16 Electrical Cabinets and Enclosures
4. 26 05 33 Boxes for Electrical Systems

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 SUBMITTALS

A. Product Data: If materials are by manufacturers other than specified, submit product data giving complete description.

1.5 MANUFACTURERS

A. Listed with Materials.

B. Acceptable Manufaturers

1. Kindorf
2. Unistrut
3. Caddy

PART 2 - PRODUCTS

2.1 MATERIALS

A. Continuous Slotted Channel: #12 gauge steel, electrogalvanized, with zinc chromate, bases and dimensions as required for application.

B. Hanger Rods: Continuous thread, electrogalvanized, with zinc chromate, sizes as required for loads imposed.

C. Hex Head Cap Screws and Nuts: No. H-113 and No. H-114, respectively.

D. One-Hole Pipe Straps: Series HS-100, galvanized steel

E. Single Bolt Channel Pipe Straps: Steel, with machine screws and nut, Series C-105 and Series C-106.

F. Lay-In Pipe Hanger: Series C-149.

G. Conduit and Pipe Hanger: Series 6H.

H. Beam Clamps: Series 500, RC, EC, and PC for applications.

I. Concrete Inserts, Spot: Series D-256 or No. D-255.

J. Concrete Inserts, Channel: Series D-980 or Series D-986.

K. Riser Clamps: Series C-210.

L. Cable Supports: O-Z/Gedney Type S.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Carefully lay out and provide concrete inserts.

B. Securely fasten and support conduits and raceways to the building structure.

C. Suspend horizontal runs of conduit and raceways from the floor and roof construction by rod hangers spaced 10 feet on less on centers for sizes 2-1/2 inches and greater and 9 feet or less on centers for sizes 2 inch and smaller.

D. Fasten single runs of conduit to the structure with one-hole pipe straps and beam clamps or hang on rod hangers.

E. Support multiple runs of conduit and raceways from continuous channel inserts or from trapeze hangers constructed of rod hangers and channels.

F. Fasten single conduits to rod hangers with adjustable lay-in pipe hangers or for 2 inches and smaller conduits with Series 6H pipe hangers.

G. Fasten conduits to channels with pipe channel straps.

H. Support conduits and raceways within 3 feet of each end of each bend, of each termination, and at other intervals to maintain horizontal and vertical alignment without sag and deformation.

I. Do not use cable, strap, and wire hangers as fasteners.

J. Provide riser clamps for conduits at floor lines. Provide wire and cable supports in pull boxes for risers in accordance with NEC Section 300-19 and Table 300-19 (a).

K. Install supports to permit equally distributed expansion and contraction of conduits and raceways with expansion joints. Use guides or saddles and U-bolts and anchors designed for equal effectiveness for both longitudinal and transverse thrusts.

L. Do not support conduits and raceways for equipment connections.

M. Provide special supports with vibration dampers to minimize transmission of vibrations and noises.

N. Provide trapeze hangers for conduits and raceways where routing interferes with ducts

O. Provide hangers, racks, cable cleats and supports for wires and cables in cable chambers and other locations to make a neat and substantial installation.

P. Provide angle iron and channel supports to the floor and structure for panelboards, cabinets, pull and junction boxes. Support independently from entering conduits and raceways. Provide supports as specified for conduits and raceways for outlet boxes and pull boxes 100 cubic inches and smaller.

Q. Provide supports sized for the ultimate loads to be imposed.

3.2 CLEANING

A. Clean surfaces to be painted.

END OF SECTION

SECTION 26 05 32

RACEWAYS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included: Provide a mechanically and electrically complete conduit system.

B. Related work specified in other sections:

1. 26 00 00 Electrical
2. 26 05 19 Low Voltage Electrical Power Conductors and Cables
3. 26 05 29 Hangers and Supports for Electrical Systems
4. 26 05 23 Control Voltage Electrical Power Cables

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 SUBMITTALS

A. Samples: Provide samples upon specific request.

B. Product Data: If materials are by manufacturers other than those specified, submit product data giving complete description for sizes employed, material types, and installation methods.

C. Certificates:

1. Labels of Underwriters' Laboratories, Inc. affixed to each item of material.
2. If materials are by manufacturers other than those specified submit certification that material meets applicable Underwriters' Laboratories, Inc. Standards.
3. Labels of ETL Verified PVC-001 affixed to each PVC Coated Galvanized Rigid Conduit.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect conduits and finishes from damage.

1.6 MANUFACTURER

A. The materials shall be the products of a manufacturer with a minimum of ten years experience in the manufacture of similar equipment.

B. Acceptable Manufacturers

1. Metallic Conduits: Allied, and Wheatland.
2. Nonmetallic Conduits: Cantex, and SEDCO.

3. PVC Coated Metallic Conduits: Plastibond, Permacote, and Korkap.
4. Others: As listed with products.

1.7 WARRANTY

A. The materials shall be warranted to be in proper working condition for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rigid Metal Electrical Conduit: Hot-dipped galvanized steel with zinc coated threads and an outer coating of zinc bichromate, complete with one coupling and one end thread protector. Intermediate metal conduit (IMC) is not allowed.

B. Electrical Metallic Tubing: Welded, electro-galvanized thin wall steel tubing.

1. Conduit for power wiring shall be natural electro galvanized.
2. Conduit for other systems shall be color coded in accordance with Section 26 05 23 - Control Voltage Electrical Power Cables.

C. Flexible Metal Electrical Conduit: Hot-dipped galvanized steel strip core with integral copper ground wire on sizes 1-1/4" and smaller.

D. Liquidtight Flexible Metal Electrical Conduit: Hot-dipped galvanized steel strip core with extruded polyvinyl jacket.

E. Rigid Nonmetallic Electrical Conduit: Schedule 40 heavy wall polyvinylchloride, high impact resistant.

F. PVC Coated Galvanized Rigid Conduit: The PVC coated galvanized rigid conduit must be UL Listed. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations must be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standard may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.

G. Elbows and Bends:

1. All Types: Size 1-1/4 inch and larger shall be factory manufactured.

H. Bushings:

1. 1-1/4" and Smaller: Same material as the conduit with which they are installed.
2. 1-1/2" and Larger: Hot-dipped galvanized with thermosetting phenolic insulation, 150 Deg.C.

I. Locknuts:

1. 1-1/2" and Smaller: Zinc plated heavy stuck st eel, O-Z/Gedney.
2. 2" and Larger: Cadmium plated malleable iron, O-Z/Gedney.

J. Hubs: Cadmium plated malleable iron, tapered threads, neoprene "O" ring, insulated throat, O-Z/Gedney.

K. E.M.T. Compression Connectors: Gland compression type, zinc plated steel body, cadmium plated, malleable iron nut, insulated throat, O-Z/Gedney.

L. E.M.T. Compression Couplings: Gland compression type, zinc plated steel body, cadmium plated malleable iron nut, O-Z/Gedney.

M. Liquidtight Conduit Connectors: Cadmium plated malleable iron body and nut, cadmium plated steel ferrule, insulated throat, integrally cast external ground lug, O-Z/Gedney.

N. Seals for Watertight Wall and Floor Penetrations: Malleable iron body, oversize sleeve, sealing ring, pressure clamp and rings and sealing grommet, hex head cap screws, O-Z/Gedney.

O. Seals for Penetrations through Existing Walls: Thunderline Corporation Link-Seal watertight sleeves, complete with wall and casing seals.

P. Fire Seals: Galvanized iron pipe sleeves sealed with approved foam type fireproofing.

Q. Expansion Fittings: Hot-dipped galvanized malleable iron with bonding jumpers selected for linear or linear with deflection, as required.

R. Escutcheons: Chrome plated sectional floor and ceiling plates, Crane No. 10.

S. Accessories: Reducers, bushings, washers, etc., shall be cadmium plated malleable iron on the forms and dimensions best suited for the application.

T. Identifying Tape for Underground Conduits: Polyethylene tape, 6 inches wide, with continuous printing along length, Brady Identoline:

1. For Electric Power Conduits: Yellow with black letters.
2. For Other Services: Green with black letters.

U. Sleeves: 22 gauge galvanized steel sleeves where conduits pass through walls and floors. Standard galvanized steel pipe where conduits pass through beams, outside walls, or structural members.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces to which conduits are to be secured for:

1. Defects which will adversely affect the execution and quality of work.
2. Deviations from allowable tolerances for the building material.

B. Do not start work until defects and deviations are corrected.

3.2 INSTALLATION

A. Size conduits as indicated on the drawings and as required by the NEC for the number and sizes of wires to be drawn into conduit. Do not use conduit sized less than 3/4" unless specified otherwise.

B. Conceal conduits from view in all areas except mechanical and electrical equipment rooms and crawl spaces. Should it appear necessary to expose any conduit:

1. Bring to the attention of the Architect, immediately, and
2. Rearrange the work to facilitate an approved installation.

C. Install all conduits at elevations and locations to avoid interference with grading of other work, the structure, finished ceilings, walls. Avoid causing cutting of masonry units.

D. To prevent displacement, securely support and hold in place all conduits installed in advance of other work and to be concealed in the building structure.

E. Carefully lay out conduits run within the structure, such as floors, beams, walls, to avoid densities excessive for the construction. Relocate those conduits when excessive densities occur.

F. Ream, remove burrs, and swab inside conduits before conductors are pulled in.

G. Cap or plug conduits with standard manufactured accessories as soon as the conduits have been permanently installed in place.

H. Bends and offsets in 1" and smaller conduits may be done with approved bending devices. Do not install conduits which have had their walls crushed and deformed and their surface finish damaged due to bending.

I. Where space conditions prohibit the use of standard ells, elbows, and conduits, use cast ferrous alloy fittings of such forms and dimensions as best required for the application.

J. Make all conduit joints mechanically tight, electrically continuous, and watertight. Pitch conduits in a manner to avoid creating moisture traps.

K. Install insulated throat threaded hubs on conduits entering enclosures without threaded hubs where exposed to damp or wet locations.

L. Connect and couple E.M.T. with compression type fittings. Do not use indentor and set screw fittings.

M. Install and neatly rack exposed conduits parallel with and perpendicular to the building walls. Do not install exposed diagonal conduit runs.

N. Route and suspend conduits crossing expansion joints to permit expansion, contraction, and deflection utilizing approved fittings to prevent damage to the building, conduits, and supporting devices in accordance with the National Electrical Code.

O. Do not run conduits exposed on the roof unless approval is obtained prior to installation.

P. Do not place conduits in close proximity to equipment, systems, and service lines, such as hot water supply and return lines, which could be detrimental to the conduit and its contents. Maintain a minimum 3" separation, except in crossing, which shall be a minimum 1".

Q. Connect motors, equipment containing motors, equipment mounted on an isolated foundation, and other equipment and devices which are subject to vibration and which require adjustment with flexible metallic conduit from the device to the conduit serving it. Size the flexible conduit length more than 12 diameters, but less than 18 diameters. Rigidly support the points of attachment on each side of the connection.

R. Install escutcheons on all exposed conduits passing through interior floors, walls, or ceilings. Install fire sealing materials on all conduits passing through fire rated partitions. Install wall and floor fire seals on all conduits passing through exterior walls and floors.

S. Conduit sleeves shall be sized to permit insertion of conduit with adequate clearance for movement due to expansion and contraction. Where conduits pass through outside walls, watertight fittings, as specified herein, shall be used.

T. Provide pullstring in each empty conduit. Label pullstring when conduit termination is not obvious.

3.3 USES PERMITTED

A. Rigid Metal Conduit:

1. Exterior conditions above grade.
2. Interior wet or damp locations.
3. Hazardous locations.
4. Mechanical equipment rooms.
    a. Sizes 2” and larger.
5. Lower Level of the building.
    a. Sizes 2” and larger.

B. Schedule 40 PVC with concrete encasement:

1. Below grade exterior to the building.

a. Electric Service Entrance conduit.

C. Schedule 40 PVC without concrete encasement:

1. Below grade interior to the building.

a. Electric services below floor slab.
b. Communications services below floor slab.

2. Below grade exterior to the building.

a. All size electric conduits
b. Communication Services

D. Electrical Metallic Tubing:

1. All uses above grade interior to the building, except as limited elsewhere in this section.

E. Steel Armor Clad Cable:

1. Concealed in walls and above ceilings.
2. Final connection from junction boxes on structure to individual light fixtures. Fixture-to-fixture wiring not permitted.
3. Home runs from first junction box to panelboards shall be EMT.

F. Flexible Metal Conduit:

1. Final connection to vibrating or adjustable equipment.
2. Connection to vibrating equipment shall contain one 90 degree bend.

G. Liquid tight Flexible Metal Conduit:

1. All uses permitted for flexible metal conduit.

a. In damp or wet locations.
b. Exterior to the building.
c. Food service areas.

END OF SECTION

SECTION 26 05 33

BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all of the Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included: Provide outlet boxes for the installation of wiring devices, lighting fixtures, and power and control connections.

B. Related work specified in other section:

1. Electrical: Section 26 00 00
2. Wiring Devices: Section 26 27 26
3. Lighting: Section 26 51 00
4. Control Voltage Electrical Power Cables: Section 26 05 23

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 SUBMITTALS

A. Samples: Provide samples upon specific request.

B. Product Data: If materials are by manufacturers other than those specified, submit product data giving complete description for sizes employed, material types, and electrical ratings.

1.5 MANUFACTURERS

A. Listed with Materials.

1. Appleton Electric Company
2. Raco
3. Steel City
4. Crouse Hinds
5. Hubbell
6. Raceway Components
7. Walker

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flush Mounted Outlet Boxes: Standard, stamped galvanized steel with factory conduit knockouts, one piece and welded construction:

1. Series 4S and 4S0 square boxes with covers.
2. Series M1, M2, M3 - 250 and Series M1, M2, M3 - 350 masonry boxes with covers.
3. Series 2G and GC-5075 switch boxes with covers.
4. Series OCR concrete rings with Series OCP and OCP-3/8 back plates.
5. Series 40 and 40D octagonal boxes with raised covers.
6. Series SX expandable bar hangers.

B. Surface Mounted Outlet Boxes: Cast metal with threaded hubs. Type FS and FD of form suited to the application.

C. Fire Rated, Flush, Poke-Thru Outlets: Raceway Components, Inc. #RC-700A.

D. Fire Rated, Flush, Poke-Thru Outlets with Conduit Adapter: Raceway Components, Inc. #RC-700-6-A.

E. Floor Outlet Boxes: Floor boxes and service fittings shall be flush, concealed service type, UL listed, suitable for simultaneous use for power, communications, data processing, etc. Boxes shall have concealed service top (no carpet or tile floor flange type lid), hinged floor plate and retractable exit. Color and finish to be selected by architect on product submittal.

1. Approved floor boxes are:

a. High Capacity Floor Box with Multi-Service – Legrand, Evolution Series Six-Gang Floor Box

1) Provide box, hardware and all fittings to accommodate the quantity of device activation as indicated for each type and quantity of service shown on power and technology plans.
2) Provide box with custom color cover and trim suitable for floor insert. Custom color as selected by architect.
3) Coordinate depth of concrete floor depression with contractor to accommodate depth of box.

b. Round Poke-Through Floor Box – Legrand, Evolution Series

1) Modular furniture multi-wire circuit feed – 6” minimum size

a) Provide box, hardware and all fittings to accommodate the quantity of feeds as indicated on power plans.
b) Provide box with custom color cover and trim suitable for floor insert. Custom color as selected by architect.

c. Modular furniture network cabling feed

1) Modular furniture multi cable network feed – 6” minimum size (verify capacity)

a) Provide box, hardware and all fittings to accommodate the quantity of network cables as indicated on technology plans.
b) Provide box with custom color cover and trim suitable for floor insert. Custom color as selected by architect.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine building structure to which outlet boxes are to be secured for defects which affect the execution and quality of work.

B. Do not start work until defects are corrected.

3.2 PREPARATION

A. Carefully measure and lay out exact locations in conference with the Construction Manager.

B. Owner may change outlet box locations a distance of 5 feet before rough-in without additional cost.

3.3 INSTALLATION

A. In dry walls for single and two gang outlet provide 4S and 4D boxes; for 3 or more outlets use masonry boxes.

B. In poured concrete floors, provide cast flush floor boxes complete with service fittings and carpet flanges (if required).

C. In block and masonry walls provide masonry boxes of depths required for wall thickness.

D. In poured concrete and plastered walls provide 4S and 4D boxes for single gauge outlets and 2G and 3G-5075 boxes for multiple ganged outlets.

E. In concrete ceiling provide OCR rings.

F. In other ceilings provide 40 and 40D boxes. Omit covers if standard canopy and device plates entirely cover the ceiling opening.

G. In exposed work, exterior of the building, in wet locations, and flush in non-waterproofed walls below grade provide FS and FD boxes.

H. Submit for approval special boxes for special devices and applications. Size according to device and application in accordance with NEC.

I. Install outlet boxes finished to within 1/8 inch of finished surfaces.

J. Install center of box at heights above finished floor:

1. Wall Switches: 45 Inches
2. Convenience Outlets: 18 Inches
3. Telephone/Data Outlets: 18 Inches
4. Wall Telephone Outlets: 45 Inches
5. Boxes Indicated Above Counters: 4 Inches above backsplash and trim, unless otherwise indicated.

K. Install wall switch outlet boxes on the strike side of doors as finally hung.

L. Group outlet on circuits with homeruns as indicated on the Drawings.

M. Do not provide through-the-wall and back-to-back boxes unless specifically noted on the drawings.

N. Provide standard manufactured plugs in unused openings of boxes.

O. Provide boxes at the terminal of conduit runs to outlets and devices.

P. Provide plaster rings and covers where required by the building structure.

Q. In brick finished walls, locate to work brick in a brick course where possible, and to permit conduits and raceways to enter from the rear without cutting brick, where possible.

R. Provide 3/8 inch studs and lighting fixture outlet boxes where shop drawings of fixtures require and elsewhere as may be required for fixtures.

S. Rigidly attach to structure and ceiling supporting members in suspended ceilings to avoid cutting mechanical ceiling members.

T. Center outlet in paneling and in other Architectural features.

U. Locate light fixture outlets in uniform relation with ceiling tiles.

V. Label all junction boxes with circuit information as to its use for special system equipment. Use an indelible marker to mark information on cover.

3.4 CLEANING

A. Clean surfaces to be painted.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all of the Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Provide identification of electrical equipment.

B. Provide identification of over current devices.

C. Provide identification of branch circuits, outlets, and wiring devices.

D. Provide identification of required clear working spaces for electrical equipment.

E. Provide identification of rooms and spaces for access by qualified personnel.

F. Related work specified in other section:

1. Section 26 05 33: Boxes for Electrical Systems.
2. Section 26 22 13: Low Voltage Distribution Transferences.
3. Section 26 24 13: Circuit Breaker Distribution Switchboards.
4. Section 26 24 16: Panelboards.

1.3 QUALITY ASSURANCE

A. Signs and plackards shall meet the requirements by OSHA.

1.4 SUBMITTALS

A. Submit literature describing all signage and marking materials to the Architect for approval prior to installation.

PART 2 - PRODUCTS

2.1 PLACKARDS

A. Plackards shall be engraved phenolic name plates with engraved lettering engraved. Lettering shall be minimum 24 point type in basic block font.

B. Plackards shall be securely and permanently adhered to the equipment enclosures without fasteners or penetrations into the enclosures.

C. Plackards shall be color coded for various systems as follows:

1. Utility Power Systems: White plackard, black lettering.
2. Generator Power Systems: Red plackard, white lettering.
3. UPS or UPS-A Systems: Gray plackard, white lettering.
4. UPS-B Systems: Brown plackard, white lettering.
5. Other Systems: As directed by Owner.

2.2 LABELS

A. Labels shall be typewritten, adhesive backed printed labels. Lettering shall be minimum 18 point type in basic black font.

2.3 MARKING MATERIALS

A. Materials for marking of required working clearance shall be adhesive backed yellow tape, equal to 3M Company 471 Series. Clean and prepare floor surface in accordance with manufacturer's instructions.

2.4 SIGNAGE

A. Signage for electrical equipment rooms shall be preprinted manufactured sign units providing warning of the Danger of Electrical Equipment Hazards and limiting access to Qualified Personnel only.

B. Signage shall be securely and permanently adhered to the door surface without fasteners or penetrations into the door surface.

C. All signage shall be approved by the Architect prior to installation.

PART 3 - EXECUTION

3.1 SERVICE ENTRANCE EQUIPMENT

A. Provide a plackard for each service entrance equipment identifying

1. The name of the equipment.
2. The data of installation.
3. The utility company available fault current.
4. The supply system voltage.
5. The name of the engineering company of record for the project.
6. The number of service disconnecting means associated with this service.
7. The name and locations of any other service entrance equipment on the property.

B. Provide each service disconnecting means, switch or circuit breaker with a plackard identifying the device as "Service Disconnecting Means X of X Devices."

1. Utility source disconnecting means.
2. PV Source disconnecting means.
3. Wind power source disconnecting means.

C. Provide Feeder Protective Devices with a plackard identifying the name of the device or circuit number and the name of the equipment or load served.

3.2 DISTRIBUTION SWITCHBOARDS AND PANELBOARDS

A. Provide each switchboard and panelboard with a plackard identifying.

1. The name of the equipment.
2. The supply system voltage.
3. The name of the equipment supplying the switchboard or panelboard.
4. The circuit number of the overcurrent device supplying the switchboard or panelboard.

B. Provide each feeder protective device with a plackard identifying the name of the device or circuit number and the name of the equipment or load served.

3.3 LIGHTING AND APPLIANCE PANELBOARDS

A. Provide each panelboard with a plackard identifying:

1. The name of the equipment.
2. The supply system voltage.
3. The name of the equipment supplying the switchboard or panelboard.
4. The circuit number of the overcurrent device supplying the panelboard.

B. Provide each panelboard with a typewritten circuit directing card describing the name of the load served and the room number (3) where the devices are located. Reference the room number(s) actually installed at the project, not the room numbers for Architectural construction documents.

3.4 LOW VOLTAGE DISTRIBUTION TRANSFORMERS

A. Provide each transformer with a plackard identifying:

1. The name of the equipment.
2. The name of the supply source equipment and protective device circuit number.
3. The supply system voltage.
4. The load systems voltage.
5. The name of the equipment supplied from the load side of the transformer.

3.5 MEDIUM VOLTAGE DISTRIBUTION TRANSFORMERS

A. Provide each transformer with a plackard identifying:

1. The name of the equipment.
2. The name of the supply source equipment and protective device circuit number.
3. The supply system voltage.
4. The load systems voltage.
5. The name of the equipment supplied from the load side of the transformer.

3.6 OTHER EQUIPMENT

A. Provide other electrical and mechanical equipment with plackards identifying.

1. The name of the equipment.
2. The name of the supply source equipment.
3. The circuit number of the overcurrent device supplying the equipment.

3.7 OUTLET BOXES, JUNCTION BOXES AND WIRING DEVICES

A. Provide labels affixed to the inside cover for each outlet box, junction box, and wiring device identifying the panel name and branch circuit numbers for the overcurrent devices supply the circuits.

3.8 REQUIRED WORKING CLEARANCES

A. Provide marking on the floor around each item of equipment defining the required working clearances in accordance with the National Electrical Code.

3.9 ELECTRICAL EQUIPMENT ROOMS

A. Provide each entry door into a room or space containing electrical power distribution equipment providing Warning of the Electrical Hazard and restricting entrance to Qualified Personnel only.

END OF SECTION

SECTION 26 05 73

ELECTRIC POWER SYSTEM ANALYSIS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

1.2 DESCRIPTION

A. Provide a computer based fault current study utilizing industry accepted standards, practices, and analysis tools.

1. Equipment with interrupting or withstand ratings of less than the available fault current shall be identified.
2. Equipment which requires series ratings of components in order to provide adequate interrupting ratings shall be identified.

B. Provide a computer based overcurrent protective device coordination study utilizing industry accepted standards, practices, and analysis tools.

1. Components which cannot achieve full coordination shall be identified.
2. Adjustable protective devices shall be set based on the results of the study.
3. Replaceable protective devices including fuses shall be verified to be the value, rating and speed required based on the results of the study.

C. Provide a computer based arc flash hazard analysis of the electrical distribution system equipment utilizing industry accepted standards, practices and analysis tools.

1. Provide and install arc flash hazard warning labels as specified on equipment enclosures.

D. For new facilities, the scope of the system shall include the equipment shown on the one-line power diagram, specified feeder types, and equipment and devices as described in the approved equipment submittal drawings. Feeder lengths shall be appropriately estimated from scale floor plan drawings.

1. The Owner shall provide a one-line power diagram completely illustration the system or portions of the system to be included in the analysis.
2. The Owner shall provide copies of the approved submittal drawings or approved operating and maintenance manuals completely describing the equipment and component devices with electrical ratings, manufacturer, and model numbers.

E. For existing facilities the scope of the system shall be ascertained by field survey of the existing system, to include the equipment listed below as may be present on the particular site.

1. Device manufacturer, type, and ratings shall be determined by field survey.
2. Feeder sizes and types shall be determined by field survey.
3. Feeder lengths shall be appropriately estimated by field dimensions.
4. Provide the services of qualified field technical personnel to operate, de-energize and record data which may not be readily observable.
5. Obtain the Owner’s permission to de-energize equipment as required and perform those activities on times and dated specified by the Owner.

1.3 QUALITY ASSURANCE

A. All elements of the studies and analysis shall be performed under the direct supervision and control of a Professional Electrical Engineer licensed in the state where the project is located.

B. The Professional Engineer shall be experienced in the application of the software employed for a period of not less than three years, and shall be able to provide evidence of having performed successful studies of similar magnitude and complexity for electrical distribution systems employing similar devices.

1.4 REFERENCED STANDARDS

A. IEEE 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis.

B. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

C. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations.

1.5 DELIVERABLES

A. Provide two bound copies of complete study and analysis including:

1. Single line power diagrams of the electrical power distribution system utilizing nomenclature consistent with the study input data forms.
2. Fault Current Study:
    a. Study input data in tabular form.
    b. Fault current available at each bus or item of equipment, listed in tabular form.
    c. Required equipment fault current ratings at each bus or item of equipment, listed in tabular form.
    d. A listing of all components for which the fault current available exceeds the equipment fault current ratings.
3. Coordination Study:
    a. Coordination study time current curves on log-log axis graphs.
    b. A listing of all components for which clear coordination cannot be achieved.
    c. A listing of all components which are not protected within their component ratings.
    d. Pickup and time delay settings for all adjustable devices in tabular form.
    e. Fuses elections, ratings and speeds for all replaceable protective devices.
4. Arc Flach Hazard Analysis:
    a. A listing of the flash protection boundary, incident energy, working distance and hazard risk category for each item of equipment in tabular form.
    b. Copies of all Arc Flash Information labels provided for the facility.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Subject to compliance with requirements, companies offering computer software programs that may be used in the Work included, 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 diagraming time-current-characteristics 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.

D. Computer software shall be capable of printing Arc Flash information labels for installation on facility electrical equipment enclosures.

2.3 ARC FLASH LABELS

A. Arc flash labels shall be printed on self-adhesive durable material resistant to fading, moisture, or peeling.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective submittals, input and output data, and recommended device settings.
2. Impedance of utility source of supply.
3. Electrical Distribution System Diagram:
    a. Circuit breaker and fuse current ratings and types.
    b. Relays and associated power and current transformer ratings and rations.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R rations.
    d. Generator kilovolt amperes size, voltage, and source impedance.
    e. Feeders: 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-reference 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 ration for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in ampere rms symmetrical.
k. Motor controller ratings including reduced voltage types, variable frequency drive ratings, and motor controller bypasses.

3.2 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at busses and 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. Service main equipment.
2. Switchgear and switchboards.
3. Transformers.
4. Distribution switchboards.
5. Distribution panelboards.
6. Motor-control centers
7. Motor starters and controllers
8. Branch circuit panelboards

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the 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. Show calculated X/R rations and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

E. 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 ½-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.

3.3 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. 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.

2. Device settings shall protect transformers from fault currents.

C. 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.

D. 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 exits 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 ration 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.

E. Provide completed data sheets for setting of overcurrent protective devices.

3.4 ARC FLASH HAZARD ANALYSIS

A. Perform an arc flash hazard analysis for the electric power distribution system at each of the following:

1. Service main equipment
2. Switchgear and switchboards
3. Transformers
4. Distribution switchboards
5. Distribution panelboards
6. Motor control centers
7. Motor starters and controllers
8. Branch circuit panelboards

B. Arc flash hazard labels shall be provided and be installed on each item of equipment and shall include the following:

1. "Arc Flash Information" banner
2. Flash protection boundary in inches
3. Incident energy in Ca1/Cm2
4. Working distance in inches
5. PPE Category per NFPA 70E
6. Shock hazard when cover is open
7. Limited approach in inches
8. Restricted approach in inches
9. Prohibited approach in inches
10. Equipment name

11. Arc flash study date

END OF SECTION

SECTION 26 09 43

NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a networked lighting control system comprised of the following components:

1. {nLSsi}System Software Interfaces
    a. Management Interface
    b. Visualization Interface
    c. Smartphone Programming Interface for Wired Devices
    d. Smartphone Programming Interface for Wireless Devices
2. {nLSbie}System Backbone and Integration Equipment
    a. {nLSc}System Controller
3. {nLWdnd}Wired Networked Devices
    a. Wall Stations
    b. Graphic Wall Stations
    c. Digital Key Switches
    d. Auxiliary Input/Output Devices
    e. Occupancy and Photocell Sensors
    f. Wall Switch Sensors
    g. Embedded Sensors
    h. Power Packs and Secondary Packs
    i. Networked Luminaires
    j. Relay and Dimming Panel
    k. Bluetooth® Low Energy Programming Device
    l. Communication Bridge
4. {nLWsnd}Wireless Networked Devices
    a. Wireless Networked Wall Switches, Dimmers
    b. Wireless Networked Auxiliary Fixture Control Devices
    c. Wireless Networked Indoor Occupancy and Photosensors
    d. Wireless Networked Outdoor Occupancy and Photosensors
    e. Wireless Networked Indoor Embedded Sensors
    f. Wireless Networked Power Packs
    g. Wireless Networked Luminaires
5. The networked lighting control system shall meet all the characteristics and performance requirements specified herein.
6. The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

1.2 RELATED DOCUMENTS

A. 26 00 01General Provisions

1. 26 05 19 Low Voltage Electrical Power Conductors and Cables
2. 26 05 29 Hangars and Supports for Electrical Systems
3. 26 05 32 Raceways
4. 26 05 33 Boxes for Electrical Systems

5. 26 09 26 Occupancy Sensor Lighting Controls
6. 26 51 01 Interior Lighting
7. 26 51 05 Lighting Controls

B. Section 26 27 26 Wiring Devices

1. Section 26 09 23 Lighting Control Devices
2. Section 26 09 43.13 Digital-Network Lighting Controls
3. Section 26 09 43.16 Addressable Fixture Lighting Control
4. Section 26 09 43.19 Wireless Network Lighting Controls
5. Section 26 51 13 Interior Lighting Fixtures

1.3 SUBMITTALS

A. Submittal shall be provided including the following items.

1. Bill of Materials necessary to install the networked lighting control system.
2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
3. Riser Diagrams showing device wiring connections of system backbone and typical per room/area type.
4. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
5. Other Diagrams and Operational Descriptions – as needed to indicate system operation or interaction with other system(s).
6. Contractor Startup/Commissioning Worksheet (must be completed prior to factory start-up).
7. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.
8. Hardware and Software Operation Manuals.

1.4 APPROVALS

A. Prior approval from owner’s representative is required for products or systems manufactured by companies not specified in the Network Lighting Controls section of this specification.

B. Any alternate product or system that has not received prior approval from the owner’s representative at least 10 days prior to submission of a proposal package shall be rejected.

C. Alternate products or systems require submission of catalog datasheets, system overview documents and installation manuals to owner’s representative.

D. For any alternate system that does not support any form of wireless communication to networked luminaires, networked control devices, networked sensors, or networked input devices, bidders shall provide a total installed cost including itemized labor costs for installing network wiring to luminaires, control devices, sensors, input devices and other required system peripherals.

1.5 QUALITY ASSURANCE

A. Product Qualifications

1. System electrical components shall be listed or recognized by a nationally recognized testing laboratory (e.g., UL, ETL, or CSA) and shall be labeled with required markings as applicable.
2. System shall be listed as qualified under DesignLights Consortium Networked Lighting Control System Specification V2.0.
3. System luminaires and controls are certified by manufacturer to have been designed, manufactured and tested for interoperability.
4. All components shall be subjected to 100% end of line testing prior to shipment to the project site to ensure proper device operation.
5. All components and the manufacturing facility where product is manufactured must be RoHS compliant.
6. Installation and Startup Qualifications

a. System startup shall be performed by qualified personnel approved or certified by the manufacturer.

7. Service and Support Requirements

a. Phone Support: Toll free technical support shall be available.
b. Remote Support: The bidder shall offer a remote support capability.
c. Onsite Support: The bidder shall offer onsite support that is billable at whole day rates.
d. Service Contract: The bidder shall offer a Service Contract that packages phone, remote, and onsite support calls for the project. Response times for each type of support call shall be indicated in the terms of the service contract included in the bid package.

1.6 PROJECT CONDITIONS

A. Only install indoor equipment after the following site conditions are maintained:

1. Ambient Temperature: 14 to 105 degrees F (-10 to 40 degrees C)
2. Relative Humidity: less than 90% non-condensing

B. Equipment shall not be subjected to dust, debris, moisture, or temperature and humidity conditions exceeding the requirements indicated above or as marked on the product, at any point prior to installation.

C. Only properly rated equipment and enclosures, installed per the manufacturer's instructions, may be subjected to dust and moisture following installation.

1.7 WARRANTY

A. The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin on the date of shipment.

B. The hardware warranty shall cover repair or replacement any defective products within the warranty period.

1.8 MAINTENANCE & SUSTAINABILITY

A. The manufacturer shall make available to the owner new parts, upgrades, and/or replacements available for a minimum of 5 years following installation.

PART 2 - EQUIPMENT

2.1 MANUFACTURERS

A. Acceptable Manufacturers

1. Acuity Brands Lighting, Inc.

B. Basis of Design System: **Acuity Controls nLight**

2.2 SYSTEM COMPLIANCE

A. System components shall comply with UL 916 and UL 924 standards where applicable.

B. System components shall comply with CFR Title 47, Part 15 standards where applicable.

C. System components shall comply with ISED Canada RSS-247 standards where applicable.

D. All equipment shall be installed and connected in compliance with NFPA 70.

2.3 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture

1. System shall have an architecture that is based upon three main concepts: (1) networkable intelligent lighting control devices, (2) standalone lighting control zones using distributed intelligence, (3) optional system backbone for remote, time based and global operation.
2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.
3. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone (see *Control Zone Characteristics* sections for each type of network connection, wired or wireless).
4. Networked luminaires and intelligent lighting control devices shall support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
5. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”

    a. Lighting control zones (wired and wireless) of at least 128 devices per zone shall be supported.

6. Networked luminaires and intelligent lighting control devices shall have distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones shall operate according to their defined default settings and sequence of operations.
7. Lighting control zones shall be capable of being networked with a higher-level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software interface.
8. The system may include one or more system controllers that provide time-based control. The system controller also provides a means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.
9. All system devices shall support firmware update, either remotely or from within the applications space, for purposes of upgrading functionality at a later date.

B. {nLWdnd}Wired Networked Control Zone Characteristics

1. Connections to devices within a wired networked lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT5e specifications or higher. To prevent wiring errors and provide cost savings, the use of mixed types of low voltage network cables shall not be permitted.
2. Devices in an area shall be connected via a “daisy-chain” topology; requiring all individual networked devices to be connected back to a central component in a “hub-and-spoke” topology shall not be permitted, so as to reduce the total amount of network cable required for each control zone.
3. System shall provide the option of having pre-terminated plenum rated low voltage network cabling supplied with hardware so as to reduce the opportunity for improper wiring and communication errors during system installation.
4. Following proper installation and provision of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g. software application, handheld remote, pushbutton). The “out of box” default sequence of operation is intended to provide typical sequence of operation so as to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.
5. Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
6. All networked devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

7. Networked control devices intended for control of egress and/or emergency light sources shall not require the use of additional, externally mounted UL924 shunting and/or 0-10V disconnect devices, so as to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:
    a. Low-Voltage power sensing: These devices shall automatically provide 100% light level upon detection of loss of power sensed via the low voltage network cable connection.
    b. UL924 Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard, and shall automatically close the load control relay and provide 100% light output upon detection of loss of power sensed via line voltage connection to normal power.
8. Networked luminaires and intelligent lighting control devices located in different areas shall be able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy and photocell commands shall be available across a single controller, and switch commands shall be available across single or multiple controllers. These shall also be referred to as global control zones.
9. Wired networked Wall stations shall provide the follow Scene Control Capabilities:
    a. Preset Scenes that can activate a specific combination of light levels across multiple local and global channels, as required.
    b. Profile Scenes that can modify the sequence of operation for the devices in the area (group) in response to a button press. This capability is defined as supporting “Local Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage. Wall stations shall be able to manually start and stop Local Profiles, or the local profile shall be capable of ending after a specific duration of time between 5 minutes and 12 hours. Parameters that shall be configurable and assigned to a Local Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.
    c. 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local and global control zones, so as to support “multi-way” preset scene and profile scene control.

C. Wireless Networked Control Zone Characteristics

1. No wired connections between networked devices shall be required for the purposes of system communications.
2. Multiple wireless networking protocols shall be supported:
    a. A standards based, distributed star topology type of protocol for 900 MHz communication, so as to support lighting control applications and IoT applications.
    b. A Bluetooth standard protocol for 2.4 GHz communication that supports direct connection to a smartphone and tablet device, so as to support device configuration, control applications, and IoT without requiring the use of a system backbone.
3. Wireless network shall be self-healing, such that the loss of backbone or local communication between devices does not result in the loss of control of the lights in the space.
4. Wireless network communication shall support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
5. To support the system architecture requirement for distributed intelligence, wireless network communication shall support communication of control signals from sensors and wall stations to networked luminaires and wireless load control devices, without requiring any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge or gateway.
6. All wireless communication between lighting control components shall support the following five tiers of security measures.
    a. Data Encryption
    b. Firmware Protection

c. Tamper-Proof Hardware
d. Authenticated User Access
e. Mutual Device Authentication

7. Accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments, wireless networked devices shall be capable of communicating to at least 150’ spacing between devices with embedded wireless transceivers under typical site conditions.
8. Wireless networked devices shall have a line-of-sight communication range of at least 1000’ under ideal environmental conditions.

D. System Integration Capabilities

1. The system shall interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet MS/TP protocols. The following system integration capabilities shall be available via BACnet/IP and BACnet MS/TP protocols:
   a. The system shall support control of individual devices, including, but not limited to, control of relay and dimming output.
   b. The system shall support reading of individual device status information. The available status will depend on the individual device type and capabilities, which may include but not be limited to, relay state, dimming output, power measurement, occupancy sensor status, and photocell sensor states or readings. All system devices shall be available for polling for devices status.
   c. The system shall support activation of pre-defined system Global Profiles (see *Supported Sequence of Operations for further definition of Global Profile capabilities)*.
2. The system shall support activation of Global Profiles from third party systems by receiving dry contact closure output signals or digital commands via RS-232/RS-485. (See *Supported Sequence of Operations for further definition of Profile and Scene Preset capabilities.)*
3. The system shall support activation of demand response levels from Demand Response Automation Servers (DRAS) via the OpenADR 2.0a protocol.

E. Supported Sequence of Operations

1. Control Zones
   a. Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) shall be capable of transmitting and tracking occupancy sensor, photocell sensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within the area. These shall also be referred to as local control zones.
2. Wall Station Capabilities
   a. Wall stations shall be provided to support the following capabilities:
      1) On/Off of a local control zone.
      2) Continuous dimming control of light level of a local control zone.
   b. 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local control zones, so as to support “multi-way” switching and/or dimming control.
3. Occupancy Sensing Capabilities
   a. Occupancy sensors shall be configurable to control a local zone.
   b. Multiple occupancy sensors shall be capable of controlling the same local zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
   c. System shall support the following types of occupancy sensing sequence of operations:
      1) On/Off Occupancy Sensing
      2) Partial-On Occupancy Sensing
      3) Partial-Off Occupancy Sensing

4) Vacancy Sensing (Manual-On / Automatic-Off)

d. On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:

1) Occupancy sensors shall automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On sequences the designated occupied light level shall support at least 100 dimming levels.
2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.
3) To provide additional energy savings the system shall also be capable of combining Partial-Off and Full-Off operation by dimming the lights to a designated level when vacant and then turning the lights off completely after an additional amount of time.
4) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under *Photocell Sensing Capabilities.*
5) The use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.

e. Vacancy Sensing mode (also referred to as Manual-On / Automatic-Off) shall function according to the following sequence of operation:

1) The use of a wall station is required turn lights on. The system shall be capable of programming the zone to turn on to either to a designated light level or the previous user light level. Initially occupying the space without using a wall station shall not result in lights turning on.
2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.
3) To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
4) To minimize occupant impact in case the area or zone is still physically occupied following dimming or shutoff of the lights due to detection of vacancy, the system shall support an “automatic grace period” immediately following detection of vacancy, during which time any detected occupancy shall result in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.
5) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under *Photocell Sensing Capabilities.*
6) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.

f. To accommodate diverse types of environments, occupancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.

4. Photocell Sensing Capabilities (Automatic Daylight Sensing)
    a. Photocell sensing devices shall be configurable to control a local zone.
    b. The system shall support the following type of photocell-based control:
        1) Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.
5. {nLSc}Schedule Capabilities
    a. System shall support the creation of time schedules for time-of-day override of devices including offsets from dusk and dawn.
    b. System shall support blink warning and timed extension capabilities. At the end of a scheduled period, the system shall be capable of providing a visible “blink warning” 5 minutes prior to the end of the schedule. Wall stations may be programmed to provide timed overrides that turn the lights on for an additional period of time. Timed override duration shall be programmable for each individual device, zone of devices, or customized group of devices, ranging from 5 minutes to 12 hours.
6. Global Profile Capabilities
    a. The system shall be capable of automatically modifying the sequence of operation for selected devices in response to any of the following: a time-of-day schedule, contact closure input state, manually triggered wired wall station input, RS-232/RS-485 command to wired input device, and BACnet input command. This capability is defined as supporting “Global Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage.
    b. Global profiles may be scheduled with the following capabilities:
        1) Global Profiles shall be stored within and executed from the system controller (via internal timeclock) such that a dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
        2) Global Profile time-of-day schedules shall be capable of being given the following recurrence settings: daily, specific days of week, every “n” number of days, weekly, monthly, and yearly. Lighting control profile schedules shall support definition of start date, end date, end after “n” recurrences, or never ending. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
        3) Global Profile Holiday Schedules should follow recurrent settings for specific US holiday dates regardless if they always occur on a specific date or are determined by the day/week of the month.
        4) Global Profiles shall be capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
        5) Software management interface shall be capable of displaying a graphic calendar view of profile schedules for each control zone.
    c. System Global Profiles shall have the following additional capabilities:
        1) Global Profiles shall be capable of being manually activated directly from the system controller, specially programmed wired input devices, scene capable wired wall stations, and the software management interface.
        2) Global Profiles shall be selectable to apply to a single device, zone of devices, or customized group of devices.
        3) Parameters that shall be configurable and assigned to a Global Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.

d. A backup of Local and Global Profiles shall be stored on the software's host server such that the Profile backup can be applied to a replacement system controller or wired wall station.

7. System shall support automated demand response capabilities with automatic reduction of light level to at least three levels of demand response.

2.4 {NLSSI}SYSTEM SOFTWARE INTERFACES

A. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. Management interface shall require all users to login with a User Name and Password, and shall support creation of at least 100 unique user accounts.
4. Management interface shall support at least three permission levels for users: read-only, read & change settings, and full administrative system access.
5. Management interface shall be capable of restricting access for user accounts to specific devices within the system.
6. All system devices shall be capable of being given user-defined names.
7. The following device identification information shall be displayed in the Management interface: model number, model description, serial number or network ID, manufacturing date code, custom label(s), and parent network device.
8. Management interface shall be able to read the live status of a networked luminaire or intelligent control device and shall be capable of displaying luminaire on/off status, dim level, power measurement, device temperature, PIR occupancy sensor status, microphonic occupancy sensor status, remaining occupancy time delay, photocell reading, and active Profiles.
9. Management interface shall be able to read the current active settings of a networked luminaire or intelligent control device and shall be capable of displaying dimming trim levels, occupancy sensor and photocell enable/disable, occupancy sensor time delay and light level settings, occupancy sensor response (normal or vacancy), and photocell setpoints and transition time delays.
10. Management interface shall be able to change the current active settings and default settings for an individual networked luminaire or intelligent control device.
11. Management interface shall be capable of applying settings changes for a zone of devices or a group of selected devices using a single "save" action that does not require the user to save settings changes for each individual device.
12. A printable network inventory report shall be available via the management interface.
13. A printable report detailing all system profiles shall be available via the management interface.
14. All sensitive information stored by the software shall be encrypted.
15. All system software updates must be available for automatic download and installation via the internet.

B. Visualization and Programming Interfaces

1. System shall provide an optional web-based visualization interface that displays graphical floorplan.
2. Graphical floorplan shall offer the following types of system visualization:

a. Full Device Option - A master graphic of the entire building, by floor, showing each control device installed in the project with zones outlined. This shall include, but not be limited to, the following:

1) Controls embedded light fixtures
2) Controls devices not embedded in light fixtures
3) Daylight Sensors
4) Occupancy Sensors
5) Wall Switches and Dimmers
6) Scene Controllers
7) Networked Relays
8) Wired Bridges
9) System Controllers

10) Wired Relay Panels
11) {nLVi}Group outlines

b. Group Only Option - A master graphic of the entire building, by floor, showing only control groups outlined.
c. Allow for pan and zoom commands so smaller areas can be displayed on a larger scale simply by panning and zooming each floor's master graphic.
d. A mouse click on any control device shall display the following information (as applicable):

1) The device catalog number.
2) The device name and custom label.
3) Device diagnostic information.
4) Information about the device status or current configuration is available with an additional mouse click.

3. Smartphone Programming Interface for Wired Devices

a. Application interface shall be provided for both Apple iOS® and Android operating systems that allows configuration of lighting control settings.
b. The application shall support the configuration and control of wired networked control devices via a Bluetooth® Low Energy (BLE) Programming Device.

1) Application shall support a security pin-code to access the zone of lighting control devices.
2) The application shall provide indication of signal strength where multiple Bluetooth Low Energy Programming Devices are available for configuration.
3) The application shall indicate the number of wired networked control devices connected to the local daisy-chain zone.
4) The application shall provide on/off/dimming control of all control groups.
5) The application shall provide the ability to identify all individual luminaires and control devices.

c. Programming capabilities through the application shall include, but not be limited to, the following:

1) Switch/occupancy/photosensor zone configuration
2) Manual/automatic on modes
3) Turn-on dim level
4) Occupancy sensor time delays
5) Dual technology occupancy sensors sensitivity
6) Photosensor calibration adjustment and auto-setpoint
7) Multiple photosensor zone offset
8) Trim level settings
9) Preset scene creation and copy for scene capable devices.
10) Application of custom device labels to the Bluetooth Low Energy Programming Devices and individual connected lighting control devices.

4. Smartphone Programming Interface for Wireless Devices

a. Application interface shall be provided for both Apple iOS® and Android operating systems that allows configuration of lighting control settings.
b. The application shall support the configuration of wireless networked control devices

1) Application shall limit access with a user name and password
2) Access to the program information will be governed by a permission system that allows users to share access with other users and restrict access to those who should not be able to reconfigure the equipment.
3) The application shall provide indication of signal strength where multiple Bluetooth Low Energy Programming Devices are available for configuration.

c. Programming capabilities through the application shall include, but not be limited to, the following:

1) Switch/occupancy/photosensor group configuration
2) Manual/automatic on modes
3) Turn-on dim level
4) Occupancy sensor time delays
5) Dual technology occupancy sensors sensitivity
6) Photosensor calibration adjustment and auto-setpoint
7) Multiple photosensor zone offset
8) Trim level settings

2.5 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller

1. System Controller shall be multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall have 32-bit microprocessor operating at a minimum of 1 GHz.
3. System Controller shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases.
4. System Controller shall perform the following functions:
   a. Time-based control of downstream wired and wireless network devices.
   b. Linking into an Ethernet network.
   c. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
   d. Connection to various software interfaces, including management interface, historical database and analytics interface, and visualization interface.
5. System Controller shall have an integral web server to support configuration, diagnostics and hosting of software interfaces.
6. Device shall have option for a graphical touch screen to support configuration and diagnostics.
7. Device shall have three RJ-45 networked lighting control ports for connection to any of the following:
   a. The graphical touch screen
   b. Wired communication bridges
   c. Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port)
8. Device shall automatically detect all networked devices connected to it.
9. Device shall have an internal time clock used for astronomical and standard schedules.
10. Device shall have 2 switched RJ-45 10/100 BaseT Ethernet ports for local area network (LAN) connection.
    a. Ethernet connection shall support daisy chain wiring to other lighting control system LAN devices.
    b. Ethernet connection shall support IPv4 and shall be capable of using a dedicated static or DHCP assigned IP address.
11. Device shall have 2 x USB 2.0 Expansion ports for 802.11 Wi-Fi Adapter enabling wireless connectivity including:
    a. Hot Spot
    b. Access Point
    c. Client
12. Each System Controller shall be capable of managing and operating at least 750 networked devices (wired or wireless).

a. Multiple System Controllers may be networked together via LAN connection to scale the system up to 20,000 networked devices.

13. System Controller shall support BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
    a. BACnet MS/TP shall support 9600 to 115200 baud rate.
    b. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
14. System controller shall contain a “FIPS 140-2 Level 1 Inside” cryptographic module.
15. System controller shall support RESTful API control of BACnet objects, user management, date and time, and file management.
16. System controller shall be available within a NEMA 1 enclosure with Class 1 and Class 2 separation
    a. Enclosure shall support power input power of 120-277VAC, or optional 347

2.6 WIRED NETWORKED DEVICES

A. Wired Networked Wall Switches, Dimmers, Scene Controllers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
5. Devices with mechanical push-buttons shall be made available with custom button labeling.
6. Wall switches & dimmers shall support the following device options:
    a. Number of control zones: 1, 2 or 4
    b. Control Types Supported:
        1) On/Off
        2) On/Off/Dimming
        3) On/Off/Dimming/Correlated Color Temperature Control for specific luminaire types
    c. Colors: Ivory, White, Light Almond, Gray, Black, Red
7. Scene controllers shall support the following device options:
    a. Number of scenes: 1, 2 or 4
    b. Control Types Supported:
        1) On/Off
        2) On/Off/Dimming
        3) Preset Level Scene Type
        4) On/Off/Dimming/Preset Level for Correlated Color Temperature
        5) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
        6) Selecting a lighting profile to be run by the system’s upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
    c. Colors: Ivory, White, Light Almond, Gray, Black, Red

B. Wired Networked Graphic Wall Stations

1. Device shall surface mount to single-gang switch box.

2. Device shall have a 3.5”, capacitive full color touch screen.
3. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
4. Device shall have a micro-USB style connector for local computer connectivity.
5. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
6. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
7. Device shall enable configuration of all switches, dimmers, control zones, and lighting preset scenes via password protected setup screens.
8. Graphic wall stations shall support the following device options:

    a. Number of control zones: Up to 16
    b. Number of scenes: Up to 16
    c. Profile type scene duration: User configurable from 5 minutes to 12 hours
    d. Colors: White, Black

C. Wired Networked Digital Key Switches

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices shall have LED user feedback to provide indication of on/off status of the programmed lights or scene, as well as indication of device power.
5. Digital key switches shall support the following device options:

    a. Control Types Supported:

        1) On/Off
        2) On/Off/Dimming
        3) Preset Level Scene Type
        4) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
        5) Selecting a lighting profile to be run by the system’s upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

    b. Colors: Ivory, White, Light Almond, Stainless Steel

D. Wired Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½” knockout.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:

    a. Contact closure or Pull High input

        1) Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.

    b. {nLAiod}0-10V analog input

        1) Input shall be programmable to function as a daylight sensor.

    c. {nLAiod}RS-232/RS-485 digital input

1) Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.

d. 0-10V dimming control output, capable of sinking up to 20mA of current

1) Output shall be programmable to support all standard sequence of operations supported by system.

e. Digital control output via EldoLED LEDcode communication

1) Output shall be programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.

E. Wired Networked Occupancy and Photosensors

1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
6. System shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.
7. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
8. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
9. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
10. Ceiling mount occupancy sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
11. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
12. Sensors shall have optional features for photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
13. Photosensor shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
14. Photosensor and dimming sensor’s set-point and dead band shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
15. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
16. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an “offset” from the primary zone.

F. {nLWss}Wired Networked Wall Switch Sensors

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

3. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices with mechanical push-buttons shall provide tactile user feedback.
5. Wall switches sensors shall support the following device options:

    a. User Input Control Types Supported: On/Off or On/Off/Dimming
    b. Occupancy Sensing Technology: PIR only or Dual Tech acoustic
    c. Daylight Sensing Option: Inhibit Photosensor
    d. Colors: Ivory, White, Light Almond, Gray, Black, Red

G. Wired Networked Embedded Sensors

1. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
2. Occupancy sensor detection pattern shall be suitable for 7.5’ to 20’ mounting heights.
3. Embedded sensors shall support the following device options:

    a. Occupancy Sensing technology: PIR only or Dual Tech acoustic
    b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor

H. Wired Networked Power Packs and Secondary Packs

1. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC) and carry a plenum rating.
3. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power.
4. Power Supplies shall provide system power only, but are not required to switch line voltage circuit.
5. Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).
6. Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.
7. Power Pack programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
8. Power Pack shall securely mount through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
9. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
10. Power/Secondary Packs shall be available with the following options:

    a. Power Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
    b. Secondary Pack with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.
    c. Power and Secondary Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
    d. Secondary Pack capable of full 16-Amp switching of all normal power lighting load types.
    e. Secondary Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
    f. Secondary Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.
    g. Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.
    h. Secondary Pack capable of louver/damper motor control for skylights.

i. Secondary Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
j. Secondary Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BMS).
k. Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

I. Wired Networked Luminaires

1. Networked luminaire shall have a mechanically integrated control device.
2. Networked LED luminaire shall have two RJ-45 ports available (via control device directly or incorporated RJ-45 splitter).
3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers).
4. Networked LED luminaire shall provide low voltage power to other networked control devices (excluding EMG and CCT capable versions).
5. System shall be able to turn on/off specific LED luminaires without using a relay, if LED driver supports “sleep mode.”
6. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by automatically varying the dimming control signal to account for lumen depreciation.
    a. System shall indicate (via a blink warning) when the LED luminaire is no longer able to compensate for lumen depreciation.
7. System shall be able to provide control of network luminaire intensity, in addition to correlated color temperature of specific LED luminaires.
8. System shall be able to provide control of network luminaire intensity, in addition to dynamic features, such as grayscale and color accent of specific LED luminaires.

J. Wired Networked Relay and Dimming Panel

1. Relay and dimming panel shall be available with 4, 8, 12, 16, 24, 32, 40 or 48 individual relays per panel, with an equal number of individual 0-10V dimming outputs.
2. Optional Field Configurable Relays (FCR) used shall have the following required properties:
    a. Configurable in the field to operate with single-, double-, or triple-pole relay groupings.
    b. Configurable in the field to operate with normally closed or normally open behavior.
    c. Provides visual status of current state and manual override control of each relay.
    d. Listed for the following minimum ratings:
        1) 40A @ 120-480VAC Ballast
        2) 16A @ 120-277VAC Electronic
        3) 20A @ 120-277VAC Tungsten
        4) 20A @ 48VDC Resistive
        5) 2HP @ 120VAC
        6) 3HP @ 240-277VAC
        7) 65kA SCCR @ 480VAC
3. 0-10 dimming outputs shall support a minimum of 100mA sink current per output.
4. Relay and dimming outputs shall be individually programmable to support all standard sequence of operations as defined in this specification.
5. Panel shall be UL924 listed for control of emergency lighting circuits.
6. Panel shall power itself from an integrated 120-277 VAC or optional 347VAC supply.
7. Panel shall provide a configurable low-voltage sensor input with the following properties:
    a. Configurable to support any of the following input types:
        1) Indoor Photocell
        2) Outdoor Photocell
        3) Occupancy Sensor
        4) Contact Closure

b. Low voltage sensor input shall provide +24VDC power for the sensor so that additional auxiliary power supplies are not required.
c. Sensor input supports all standard sequence of operations as defined in this specification.

8. Panel shall provide a contact closure input for each group of 8-relays that acts as a panel override to activate the normally configured state of all relays (i.e., normally open or normally closed) in the panel. This input is intended to provide an interface to alarm systems, fire panels, or BMS system to override the panel.
9. Panel shall supply current limited low voltage power to other networked devices connected via low voltage network cable.
10. Panel shall be available with NEMA 1 rated enclosure with the following mounting and cover options:

a. Surface-mounted for all panel sizes
b. Flush-mounted for up to 16 relay panel sizes
c. Screw-fastened for up to 16 relay panel sizes
d. Hinged cover with keyed lock for all panel sizes

11. Surface-mounted screw cover options for 8 and 16 relay panel sizes shall be plenum rated
12. Panel shall be rated from 0-50C for 8 and 16 enclosure sizes, and 0-45C for 32 and 48 enclosure sizes.

K. Wired Networked Bluetooth® Low Energy Programming Device

1. Device shall be plenum rated and be inline wired, screw mountable.
2. Communication and low voltage power shall be delivered to device via standard low voltage network cabling with RJ-45 connectors.
3. Bluetooth Low Energy connection shall allow connection from smartphone application for programming device settings within the local daisy-chain zone (*see list of available settings in section 2.4-System Software Interfaces, Sub-section E).*

a. Device shall provide visual indication of remote Bluetooth connection via LED integrated into device enclosure such that it is visible from all angles while the zone is being programmed.

L. {nLCb}Wired Networked Communication Bridge

1. Device shall surface mount to a standard 4” x 4” square junction box.
2. Device shall have 8 RJ-45 ports for connection to lighting control zones (up to 128 devices per port), additional network bridges, and System Controller.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply, or powered via low voltage network connections from powered lighting control devices (e.g. power packs).
5. Wired Bridge shall be capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.7 WIRELESS NETWORKED DEVICES

A. Wireless Networked Wall Switches, Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
3. Devices shall have options to be powered by battery or line voltage. If powered by battery, expected battery life shall be no less than 10 years.
4. Devices with mechanical push-buttons shall provide tactile and LED user feedback during button press.
5. Devices with mechanical push-buttons shall be made available with custom button labeling.
6. Wall switches & dimmers shall support the following device options:

a. Number of control zones: 1, 2

b. Control Types Supported: On/Off or On/Off/Dimming
c. Colors: Ivory, White, Light Almond, Gray, Red

7. Scene switches shall support the following device options:

a. Number of Scenes. 2, 4
b. Control types supported

1) On/Off
2) On/Off/Dimming
3) Preset Level Scene Type

B. Wireless Networked Auxiliary Fixture Control Devices

1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Power shall be delivered to each device via standard low voltage wiring from LED driver.

C. Wireless Networked Indoor Occupancy and Photosensors

1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
3. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
4. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
5. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
6. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
7. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential issue.
8. Power shall be delivered to each device via standard low voltage wiring from a local power pack or by line voltage for devices with available nipple mount.
9. Sensor programming parameter shall be available and configurable remotely from the software
10. Network system shall have ceiling and fixture mounted sensors available, with multiple lens options available customized for specific applications.
11. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
12. Sensors shall have standard daylight photosensor for programmable daylight harvesting
13. Photosensor shall provide foot-candle setpoint and a deadband to prevent the artificial light from cycling. Set-point and deadband shall be capable of automatically calibrating through an “Automatic Set-Point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
14. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
15. Nipple mounted devices shall include option for power interruption detection, where unit powers and controls the emergency circuit, and an interruption of power to this circuit for >30 ms forces unit to shunt closed, go to full bright, and ignore all system commands for 90 minutes

D. Wireless Networked Outdoor Occupancy and Photosensors

1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Sensor shall be available in both nipple mount and in-fixture mount options

a. Nipple mount sensor shall carry IP66 rating

b. In-fixture mount sensor shall carry IP65 rating

3. Sensor shall be capable of operating in -40 to 65C ambient temperature ranges
4. Sensors shall be capable of accepting 120-277, 347, or 480VAC input or DC power for embedded device.
5. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
6. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
7. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential issue.
8. Sensor programming parameter shall be available and configurable remotely from the software
9. Nipple mounted sensors shall be available with multiple lens options available for various mounting heights
10. Sensors shall have standard daylight photosensor for programmable daylight harvesting
11. Photosensor shall provide foot-candle setpoint and a deadband to prevent the artificial light from cycling. Set-point and deadband shall be capable of automatically calibrating through an “Automatic Set-Point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
12. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., changes in car type and color, lamp outages).
13. Devices shall include option for power interruption detection, where unit powers and controls the emergency circuit, and an interruption of power to this circuit for >30 ms forces unit to shunt closed, go to full bright, and ignore all system commands for 90 minutes.

E. Wireless Networked Indoor Embedded Sensors

1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
3. Occupancy sensor detection pattern shall be suitable for 7.5’ to 40’ mounting heights.
4. Embedded sensors shall support the following configuration options:

   a. Occupancy Sensing technology: PIR only or Dual Tech acoustic
   b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor

5. Devices shall be available with options for both integrated and remote capable antennas such that devices can be optionally installed in a sealed container without detriment to wireless strength.

F. Wireless Networked Power Packs

1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output
3. Power Packs shall accept 120 through 277 VAC and carry a plenum rating.
4. Power Packs shall be available with optional 24VDC, 100mA output for use with ceiling mount sensors or other DC powered products.
5. Power Packs shall be available with options for integrated and remote capable antennas such that devices can be optionally installed in a sealed container without detriment to wireless strength.
6. Power Pack programming parameters shall be available and configurable remotely from the software
7. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
8. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
9. Power Packs shall be available with the following options:

a. Power Pack capable of full 20-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
b. Power Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
c. Power Packs with UL924 listing capable of full 20-Amp switching of all emergency power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current. There shall be two methods of achieving the UL924 operation:

1) Power sense of normal power feed, where unit powers and controls emergency circuit, and loss of the normal power sense circuit forces the power pack to shunt closed, go to full bright, and ignore all system commands until normal power is restored.
2) Power interruption detection, where unit powers and controls the emergency circuit, and an interruption of power to this circuit for >30 ms forces unit to shunt closed, go to full bright, and ignore all system commands for 90 minutes.

d. Power Packs shall have the option of mounting inside a sealed metal enclosure, with a plenum rated antenna protruding from said enclosure to allow for an IP 67 rated application.

G. Wireless Networked Luminaires

1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Networked luminaire shall have a mechanically integrated control device.
3. System shall be able to turn on/off specific LED luminaires without using a relay, if LED driver supports “sleep mode.”
4. System shall be able to provide control of network luminaire intensity

H. Wireless Networked Communication Adapter

1. A communication adapter shall be provided that interfaces with the System Controller via USB connection and interfaces with wireless networked devices via an integrated 900MHz.
2. Device shall be capable of communicating with at least 750 wireless networked devices and luminaires
3. Device shall be supplied with mounting hardware suitable for vertical ceiling mounting or for vertical mounting from a wall.
4. Device shall be unresponsive to wired and wireless communications that do not conform to the specific protocols used by the networked lighting control system.
5. Device shall be IP66 rated and shall be optionally installed in an indoor or outdoor location.
6. Device shall allow programming and control of indoor, outdoor, and industrial wireless control devices through a single user interface.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation Procedures and Verification

1. The successful bidder shall review all required installation and pre-startup procedures with the manufacturer’s representative through pre-construction meetings.
2. The successful bidder shall install and connect the networked lighting control system components according to the manufacturer’s installation instructions, wiring diagrams, the project submittals and plans specifications.
3. The successful bidder shall be responsible for testing of all low voltage network cable included in the bid. Bidder is responsible for verification of the following minimum parameters:

a. Wire Map (continuity, pin termination, shorts and open connections, etc.)
b. Length
c. Insertion Loss

B. Coordination with Owner’s IT Network Infrastructure

1. The successful bidder is required to coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.
    a. The bidder shall provide to the owner's representative all network infrastructure requirements of the networked lighting control system.
    b. The bidder shall provide to the manufacturer's representative all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.

C. Documentation and Deliverables

1. The installing contractor shall be responsible for documenting installed location of all networked devices, including networked luminaires. This includes responsibility to provide as-built plan drawing showing device address barcodes corresponding to locations of installed equipment.
2. The installing contractor is also responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floorplan software is provided as part of bid package:
    a. As-Built floor plan drawings showing device address locations required above. All documentation shall remain legible when reproducing\scanning drawing files for electronic submission.
    b. As-Built electrical lighting drawings (reflected ceiling plan) in PDF and CAD format. Architectural floor plans shall be based on as-built conditions.
        1) CAD files shall have layers already turned on/off as desired to be shown in the graphical floorplan background images. The following CAD elements are recommended to be hidden to produce an ideal background graphical image:
        Titleblock
        Text- Inclusive of room names and numbers, fixture tags and drawings notes
        Fixture wiring and homeruns
        Control devices
        Hatching or poché of light fixtures or architectural elements
        2) CAD files shall be of AutoCAD 2013 or earlier. Revit file overall floor plan views shall be exported to AutoCAD 2013.

3.2 SYSTEM STARTUP

A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed.

1. For CAT5 wired devices, low voltage network cable testing shall be performed prior to system startup.

B. System start-up and programming shall include:

1. Verifying operational communication to all system devices.
2. Programming the network devices into functional control zones to meet the required sequence of operation.
3. Programming and verifying all sequence of operations.

C. Initial start-up and programming is to occur on-site.

3.3 PROJECT TURNOVER

A. System Documentation

1. Submit software database file with desired device labels and notes completed. Changes to this file will not be made by the factory.
2. Installing contractor to grant access to the owner for the programming database, if requested.

B. Owner Training

1. Provisions for onsite training for owner and designated attendees to be included in submittal package.

END OF SECTION

SECTION 26 22 13

LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for Coordination of work with other portions of the work.

1.2 DESCRIPTION

A. Work Included: Provide low voltage distribution power transformers for the conversion of system voltages.

B. Related Work specified in other sections:

1. 26 00 00 Electrical
2. 26 28 16 Enclosed Switches and Circuit Breakers
3. 26 05 26 Grounding and Bonding for Electrical Systems

1.3 QUALITY ASSURANCE:

A. The equipment provided shall meet the requirements of the National Electrical Code and local codes and ordinances.

B. The equipment provided shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. NEMA ST-20 Dry Type Transformers for General Applications

B. NEMA TP-1 Department of Energy, 10 CFR Part 431 Energy Efficiency

C. UL 1561 Dry Type General Purpose and Distribution Transformers

D. ANSI C57.110 IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

1.5 SUBMITTALS

A. Submit manufacturer’s literature describing equipment for each transformer, including:

1. Outline dimensions.
2. Weight.
3. Allowable conduit entry locations.
4. 1/4" scale layout of proposed equipment location including required working clearances and interference with other equipment.
5. Primary and secondary terminal locations.
6. Cable connection lugs and sizes.
7. Nameplate data and phase diagram.

8. Primary voltage, phase, connections and full load current.
9. Secondary voltage, phase, connections, and full load current.
10. KVA rating.
11. Transformer impedance.
12. Designed supports for wall mounted or suspended transformer supports, prepared by a professional structured engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and off loaded in accordance with the manufacturer's published instructions.

B. Upon arrival, inspect equipment for damage incurred in shipping.

C. Store and protect equipment from moisture and dust by storing in a clean, dry, heated space. Provide additional heavy plastic cover to protect the equipment and components. Provide auxiliary heating in the section in accordance with the manufacturer's recommendations.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years experience with manufacture of similar equipment.

B. Acceptable Manufacturers:

1. Square D Company
2. General Electric/ABB

1.8 WARRANTY

A. The equipment shall be warranted to be in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 GENERAL

A. Transformers shall be general purpose dry type ventilated transformers in NEMA 1 enclosures unless specifically noted on the drawings.

B. Transformers shall be of the KVA rating, primary voltage and connection, secondary voltage and connection as indicated on the drawings.

C. All insulating materials shall meet NEMA ST20 standards and be rated for 220 Deg.C. insulation system. Transformers shall be designed for 150 Deg.C. temperature rise and maximum temperature of the top of the enclosure of 50 Deg.C., based on an ambient air temperature of 40 Deg.C.

D. Transformers 25 KVA and larger shall be provided with full rated primary voltage taps, two 2-1/2% below nominal voltage and two 2-1/2% above nominal voltage.

2.2 CONSTRUCTION

A. Coils shall be continuous wound aluminum conductor with windings brazed or welded to line and load terminations. Windings shall be vacuum impregnated with thermosetting varnish.

B. Cores shall be constructed of high grade silicon steel with low hystresis and eddy current losses. The core flux density shall be below saturation point to prevent core overheating. Transformers shall be common core, multiple core construction and Scott-T connections are not acceptable.

C. Enclosures shall be ventilated and fabricated of code gauge steel construction. Entire enclosure shall be finished with a baked polyester powder coat paint finish, ANSI 49 gray. The coating shall be U.L. recognized for outdoor use. All terminals and tap connections shall be accessible by removing a front cover plate.

D. Core and coil shall be bolted to the base of the enclosure by means of rubber vibration isolation mounts.

E. The core of the transformer shall be grounded to the enclosure by a flexible grounding conductor sized in accordance with U.L. and NEC standards.

F. The transformer shall be provided with a name plate giving primary and secondary voltages, full load ampacities, transformer impedance and phaser diagram.

2.3 SOUND LEVELS

A. Sound levels shall not exceed the following:

1. 15 to 50 KVA - 39dB
2. 51 to 112.5 KVA - 44dB
3. 112.5 to 300 KVA - 49dB
4. 301 to 500 KVA - 56dB

2.4 OUTDOOR INSTALLATIONS

A. For outdoor installations, transformers shall be provided with weather shield for NEMA 3R enclosure designation.

2.5 K-RATED TRANSFORMERS

A. Where specifically noted on the drawings, K-Rated transformers shall be rated K-13, shall be provided with 200% neutral bus and neutral conductor terminations, and shall be provided with an independent, full width electrostatic grounded shield between primary and secondary windings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Layout exact locations of transformers maintaining required working access, separation from walls, and adequate space for line and load connections as required by NEC.

B. Transformers shall be floor mounted on four inch concrete housekeeping pads with inserts for anchor bolts.

C. Transformers may be mounted on wall brackets from building structure or suspended from the floor or roof structure above only when supports designed by a professional structural engineer are submitted to the project engineer for approval.

3.2 INSTALLATION

A. Transformers installed in a location where the primary over current device does not comply with NEC requirements for a disconnecting means shall be provided with a heavy duty non-fused disconnect switch or molded case switch in a suitable enclosure.

B. Transformers installed in a location where secondary circuit conductors are in excess of NEC maximum length shall be provided with a heavy duty fused disconnect switch or molded case circuit breaker in suitable enclosure to provide secondary feeder circuit protection.

C. All transformers shall be installed on suitable neoprene vibration isolation pads to minimize transmission of noise to structure.

D. Final connection of raceways to transformers shall be by means of flexible liquid tight metal conduit approximately twelve inches in length incorporating one ninety degree bend to minimize the transmission of vibration to the raceway system.

3.3 GROUNDING

A. Ground transformer secondary to building structural steel or other approved grounding electrode with a grounding electrode conductor in accordance with NEC requirements.

B. Bond the transformer grounded circuit conductor (neutral) to the grounding electrode conductor on the line side of the transformer secondary over current device.

3.4 ADJUSTMENT

A. Adjust transformer primary taps to provide nominal name plate secondary voltages when operating at full demand capacity without over-excitement of the primary winding or over-saturation of the transformer core.

3.5 IDENTIFICATION

A. Provide a permanently affixed engraved nameplate for each transformer giving the transformer name, the source of supply, and the name of the panel or equipment served.

END OF SECTION

SECTION 26 24 13

CIRCUIT BREAKER DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Provide low voltage distribution switchboards for the distribution of electric power and protection of load feeder circuits.

B. Related work specified in other sections

1. 26 00 00 - Electrical
2. 26 43 13 - Surge Protection Devices

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. ANSI/NFPA 70 - National Electrical Code (NEC).

B. ANSI/IEEE C12.1 - Code for Electricity Metering.

C. ANSI C39.1 - Electrical Analog Indicating Instruments.

D. ANSI C57.13 - Instrument Transformers.

E. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

F. NEMA KS 1 - Enclosed Switches.

G. NEMA PB 2 - Deadfront Distribution Switchboards, File E8681

H. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

I. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.

J. UL 50 - Cabinets and Boxes.

K. UL 98 - Enclosed and Dead Front Switches.

L. UL 489 - Molded Case Circuit Breakers.

M. UL 891 - Dead-Front Switchboards.

N. UL 943 - Ground Fault Circuit Interrupters.

O. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

P. UL 977 - Fused Power Circuit Devices.

1.5 SUBMITTALS

A. Submit Shop Drawings Including:

1. Front View Elevation
2. Plan View
3. Top View
4. Single Line Diagram
5. Nameplate Schedule
6. Conduit Entry/Exit Locations and Dimensions
7. 1/4" scale layout of proposed location for equipment including required working clearances and interferences with other equipment.
8. Assembly Ratings Including
    a. Main Bus Ratings
    b. Main Lugs or main breaker ratings and location
    c. Voltage ratings
    d. Section Bus Ratings
    e. Ground Bus Ratings and Locations
    f. Short-circuit Ratings
9. Cable Terminal sizes.
10. Switchboard instrument details:
    a. Current transformer data, ratings, accuracy, burden and locations.
    b. Potential connections and location.
    c. Meter descriptive literature and functions.
    d. Control wiring diagrams and field terminal connection locations.

B. Submit manufacturer’s literature describing circuit breakers and trip units for each type and frame employed.

C. Submit manufacturer’s literature for metering equipment, current transformers, potential connections, and wiring diagrams.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and off loaded in accordance with the Manufacturer’s published instructions.

B. Upon arrival, inspect equipment for damage incurred in shipping.

C. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.

D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

F. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years experience with the manufacture of similar equipment.

B. Acceptable Manufacturers:

1. Square D Company.
2. General Electric/ABB

1.8 WARRANTY

A. The equipment shall be warranted to be in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 SWITCHBOARD - GENERAL

A. Switchboards supplied by building service transformers shall be provided with neutral to ground disconnecting links and U.L. Service Entrance Labels. Provide and install permanent name plate showing date of service and available utility fault current. Obtain available fault current in writing from utility company in project record documents.

B. Short Circuit Current Rating: Switchboards shall be rated with a short circuit current rating as indicated on the drawings, or a minimum of 65,000 A.I.C.

C. Future Provisions: All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

D. Enclosure: NEMA 1 - General Purpose.

1. Sections shall be completely front and rear aligned. Staggered arrangements are not acceptable.
2. The switchboards shall be of dead front construction.
3. The switchboard frame shall be of formed steel rigidly bolted together to support all cover plates, bussing and component devices during shipment and installation.
4. Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.
5. Each switchboard section shall have an open bottom and an individually removable top plate for installation and termination of conduit.
6. The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be ANSI #49 medium-light grey, applied by the electro-deposition process over an iron phosphate pre-treatment.
7. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
8. Top and bottom conduit areas shall be clearly indicated on shop drawings.

E. Nameplates: Provide 1" H X 3" W engraved laminated nameplates for each device. Furnish black letters on a white background for all voltages.

F. Bus Composition: Shall be plated aluminum. Plating shall be applied continuously to all bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown in the plans and shall be sized to carry 100% of that ampacity. For 4-wire systems, the neutral shall be of equivalent ampacity as the phase bus bar. Tapered bus shall not be acceptable. Full provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.

G. Bus Connections: Shall be bolted with Grade 5 bolts and conical spring washers.

H. Ground Bus: Sized per NFPA70 and UL 891 Tables 25.1 and 25.2 and shall extend the entire length of the switchboard. Provisions for the addition of future sections shall be provided.

I. Accessibility: Accessible from the front only.

2.2 SWITCHBOARD DEVICES

A. Main Breaker

1. Electronic Trip Insulated Case Circuit Breaker

a. Fixed Mounting, Two-Step Stored Energy:

1) Circuit breaker(s) shall have power terminals to accommodate either cable or bolted bus connections.
2) Circuit protective devices shall be two-step stored energy circuit breaker. They shall be UL Listed for 100% continuous current when applied in switchboards. Sensor ampere ratings shall be as shown on the drawings.
3) Provide a fixed instantaneous circuit on breaker(s). The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 30 cycles during overcurrents below the rms symmetrical short time withstand ratings. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.
4) Circuit breaker(s) shall utilize a glass reinforced insulating material providing high dielectric strength. Current carrying components shall be completely isolated from the handle and the accessory mounting area. Breaker(s) shall have common tripping of all poles and shall be trip free. The circuit breaker shall be UL Listed for reverse connection without requiring special construction or labeling. The breaker(s) shall have quick-make, quick-break contacts with a maximum 5 cycle closing time. All circuit breakers shall be equipped with electrical accessories as noted on the drawings.
5) Circuit breaker(s) shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
6) Breaker faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.
7) Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism.
8) Electronic Trip System

a) The entire trip system shall be a microprocessor-based, true rms sensing design with sensing accuracy through the 13th harmonic, equal to type MICROLOGIC full function trip system.
b) Provide the following time/current curve shaping adjustments to maximize system selective coordination. Each adjustment shall have discrete settings and each function is independent from all other adjustments.

(1) Adjustable Long Time Ampere Rating and Delay
(2) Adjustable Short Time Pickup and Delay (delay includes I^2t IN and I^2t OUT)
(3) Adjustable, Defeatable Instantaneous Pickup (with OFF position)
(4) Adjustable Ground Fault Pickup and Delay (delay includes I^2t IN and I^2t OUT)
(5) High Level Selective Override

9) Circuit breaker shall display phase current of A, B, and C phases and ground fault (when applicable) in real-time. Circuit breaker shall contain trip indicators which shall indicate that the circuit breaker has tripped as a result of over current, short circuit, or ground fault.

B. Branch Circuit Breakers

1. Electronic trip molded case standard function 80% rated circuit breakers.

a. Group mounted through 1200 amperes.
b. Individually mounted above 1200 amperes. Each circuit breaker shall have power terminals to accommodate either cable or bolted bus connections.
c. Electronic Trip System

1) The entire trip system shall be a microprocessor-based, true RMS sensing design with sensing accuracy through the 13th harmonic, equal to MICROLOGIC full function trip system.
2) Provide the following time/current curve shaping adjustments to maximize system selective coordination. Each adjustment shall have discrete settings and each function is independent from all other adjustments.

a) Adjustable Long Time Ampere Rating and Delay
b) Adjustable Short Time Pickup and Delay (delay includes I^2t IN and I^2t OUT)
c) Adjustable, Defeatable Instantaneous Pickup (with OFF position)
d) High Level Selective Override

3) Each circuit breaker shall be capable of being removed from the front of the switchboard.

2.3 INSTRUMENTATION

A. With the main circuit breaker, provide a Square D PowerLogic PM5000 series meter with the following characteristics:

1. Current/Voltage Inputs

a. The meter shall have no less than 4 voltage inputs and 5 current inputs
b. The meter in its standard configuration shall be able to accept 600VAC without using potential transformers.
c. The meter shall be able to withstand 1500 VAC RMS continuously.
d. The meter shall support nominal current ratings of 1A, 2A, 5A, 10A, and/or 20A.

2. Provide at minimum the following voltage & current values:

a. Voltage L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, 3-Phase Avg, Voltage % unbalanced
b. Current values: Current Per-Phase, Current, Neutral (measured), Current 3-Phase Avg, Current % Unbalanced.
c. Power & energy values:
- Real Power (Per-Phase, 3-Phase Total)
- Reactive Power (Per-Phase, 3-Phase Total)
- Apparent Power (Per-Phase, 3-Phase Total)
- Power Factor – True (Per-Phase, 3-Phase Total)
- Power Factor – Displacement (Per-Phase, 3-Phase Total
- Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh)
- Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh)
- Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh)
- Reactive Energy by Quadrant

2.4 SURGE SUPPRESSION DEVICE (SPD)

A. Provide SPD protection externally mounted to the switchboard specified in Section 26 43 13, Surge Suppression Devices.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine area to receive switchboard to provide adequate clearance for switchboard installation.

B. Check that concrete pads are level and free of irregularities.

C. Start work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install switchboard in accordance with manufacturer's written guidelines, the NEC, and local codes.

3.3 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.

C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Physically test key interlock systems to check for proper functionality.

E. Test ground fault systems by operating push-to-test button.

3.4 IDENTIFICATION

A. Provide engraved switchboard nameplate permanently affixed to main lug or main breaker section cabinet giving switchboard name designation, system voltage, and name of switch board supply source.

B. Provide each branch or feeder device with LN engraved nameplate permanently affixed to the cabinet adjacent to the device giving the name of the load served.

1. Spare devices or devices for future loads shall be so identified.
2. Spaces prepared for future devices shall be so identified, along with the maximum ampere rating or frame size the prepared space can accept.

C. Provide identification in accordance with Section 26 05 53 - Identification for Electrical Systems.

D. Provide permanent identification for low voltage, control, metering, and instrumentation terminal blocks and individual terminals.

3.5 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement per manufacturers specifications.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings to values as instructed by the Engineer.

3.6 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

B. Throughout the construction period, maintain switchboard and interior free of duct, debris, wire trimmings, etc. Provide heavy duty plastic barriers as required.

C. Before final acceptance thoroughly clean switchboards and interiors and vacuum clean to a dust free condition.

3.7 TRAINING

A. Provide eight hours of training for the Owner’s personnel in the operation and maintenance of the equipment.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Provide lighting and appliance branch circuit panelboards, circuit breakers and accessories.

B. Related work specified in other sections:

1. 26 00 00 - Electrical

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. NEMA PB 1 - Panelboards

B. NEMA PB1.1 - Instructions for Sate Installation, Operation and maintenance of Panelboards Rated 600 Volts or Less.

C. NEMA AB 1 - Molded Case Circuit Breakers

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

E. UL 50 - Enclosures for Electrical Equipment

F. UL 67 - Panelboards

G. UL 98 - Enclosed and Dead-front Switches

H. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures

I. Federal Specification W-P-115C - Type Class 1

J. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.

1.5 SUBMITTALS

A. Submit Shop Drawings including:

1. Voltage Ratings.
2. Main lug or breaker rating and location voltage ratings.
3. Main Bus Rating.
4. Neutral Bus Rating and location.

5. Ground Bus Rating and location.
6. Thru-feed or sub-feed lug ratings and location.
7. Overall Panelboard Dimensions.
8. Interior Mounting Dimensions.
9. 1/4" scale layout of proposed equipment location including required working clearances, interference with other equipment and available recessing depth where applicable.
10. Location and arrangement of branch breakers.
11. Number of poles, trip ratings, and interrupting ratings of branch breakers.
12. Top and bottom conduit entries and knockouts.
13. Enclosure NEMA Type.
14. Panel deadfront, trim, door, hinge and locking provisions.
15. Manufacturer's literature describing circuit breakers and trip units for each type and frame employed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be included and off loaded in accordance with the manufacturer's published instructions.

B. Upon arrival, inspect equipment for damage incurred in shipping.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

D. Conform to NEMA PB2 service conditions during and after installation of panelboards.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years experience with the manufacturer of similar equipment.

B. Acceptable Manufacturers:

1. Square D Company.
2. General Electric/ABB

1.8 WARRANTY

A. The equipment shall be warranted to be in proper working prder for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 GENERAL

A. Interior:

1. Shall be equal to Square D type NF panelboard for 480 volt and Square D NQOB for 208 volt. Continuous main current ratings, as indicated on drawings.
2. Minimum Short Circuit Rating:

   a. 65,000 rms symmetrical amperes at 480Y/277 or as indicated on the Drawings.
   b. 25,000 rms symmetrical amperes at 208Y/120 or as indicated on the Drawings.
   c. All panelboard components shall be fully rated for the required short circuit interrupting rating. Series rating of devices is not permitted.

3. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current rating shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing shall be plated aluminum. Bus bar plating shall run the entire length of the bus bar.

Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.

4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
5. A solidly bonded aluminum equipment ground bar shall be provided. An additional aluminum isolated/insulated ground bar shall also be provided as indicated on the Drawings.
6. UL Listed panelboards with 200% rated solid neutral shall be plated aluminum for non-linear load applications. Panelboards shall be marked for non-linear load applications.
7. Interior trim shall be dead-front construction to shield user from energized parts. Dead-front trim shall have filler plated covering unused mounting space.
8. Nameplate shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA/UL Listed label ans short circuit current rating shall be displayed on the interior or in a booklet format.
9. Interiors shall be field convertible for top or bottom incoming feed. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
10. Interior phase bus shall be pre-drilled to accommodate field installable options (i.e., Sub-Feed Lugs, Sub-Feed Breakers, and Thru-Feed Lugs).
11. Interiors shall accept 125 ampere breakers in group mounted branch construction.

B. Main Circuit Breaker

1. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40 Deg.C. ambient environment. Thermal elements shall be ambient compensating above 40 Deg.C.
2. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located in the front of the breaker that allows the user to simultaneously select the desired trip level all poles.
3. Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breaker shall be CSA and UL Listed for reverse connection without restrictive line or load markings.
4. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
5. Lugs shall be UL Listed to accept solid or standard copper and aluminum conductors. Lugs shall be suitable for 75 Deg.C. eated wire.
6. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

C. Branch Circuit Breakers

1. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the drawings.
2. Molded case branch circuit breakers shall have bolt-on type bus connectors.
3. Circuit breakers shall have an overcurrent toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles
4. The exposed faceplates of all branch circuit breakers shall be flush with one another.
5. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 75 Deg.C. rated wire.
6. Breakers shall UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.
7. Breaker shall be UL Listed with the follow ratings: (15-125A) Heating, Air Conditioning, and Refrigeration (HACR), (15-30A) High Intensity Discharge (HID), (15-20A) Switch Duty (SWD), (15-50A) Equipment Protection Device (EPD) (480Y/277Vac maximum).

D. Enclosures

1. Type 1 Boxes

   a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel not acceptable.

b. Boxes shall have removable endwall with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
c. Box width shall not exceed 20" wide.

2. Type 1 Fronts

a. Front shall meet strength and rigidity requirements per UL 50 Standards. Shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
b. Mounting shall be flush or surface as indicated on the Drawings.
c. Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.
d. Fronts shall be hinged door-in-door construction with front trim connected to enclosure with continues piano hinge and latch to access all wiring and termination without removing the door from the enclosure. A separate door, hinge and latch shall be provided to access the deadfront compartment to provide access to main and branch breaker operating handles with no exposure to energized parts.

3. Type 3R, 5 and 12

a. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
b. All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59 inches or more in height. All lock assemblies shall be keyed alike. One 91) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.
c. Maximum enclosure dimensions shall not exceed 21" wide and 9.5" deep.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer’s written instructions, NEMA PB 1.1 and NEC standards.

B. Provide panelboard supports to the building structure independent of raceways.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer’s written specifications.

3.3 IDENTIFICATION

A. Provide engraved panelboard nameplate permanently affixed to the panel boor, giving panelboard name designation, system voltage, and name of the panelboard supply source.

B. Provide a neatly typewritten circuit directory card in card holder inside panel door describing the name and location of devices served by each branch breaker using numbers finally established at the project.

3.4 FUTURE PROVISIONS

A. From each flush mounted panelboard section, provide a minimum of two 1" conduits stubbed into the accessible ceiling and/or crawl space, as may be available, for future branch circuit wiring.

B. Provide a pull cord in all future conduits with identifying tags on both ends.

3.5 COORDINATION OF LOADS SERVED

A. Confirm that all branch circuit breakers are of the proper type and configuration for the loads finally connected:

1. HCAR Rated.
2. HID Rated.
3. GFCI Rated.
4. AFCI Rated.
5. Three pole common trip breakers for multi-wire branch circuits.

B. Reconnect loads, rearrange branch circuit breakers of provide new breakers as required to insure branch circuit breakers are proper type and properly rated for the loads finally connected.

3.6 CLEANING

A. Throughout the construction period, maintain panelboards and interiors free of dust, debris, wire trimmings, etc. Provide heavy duty plastic barriers as required.

B. Before final acceptance, thoroughly clean panelboards and interiors and vacuum clean to a dust free condition.

3.7 TRAINING

A. Provide eight hours of training for the Owner’s personnel in the operation and maintenance of the equipment.

END OF SECTION

SECTION 26 27 16

ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 REFERENCE DOCUMENTS

A. Conditions of the Contract and Division 01 - General Requirements are hereby made a part of this section.

B. All sections of this specification.

1.2 DESCRIPTION

A. Work Included: Provide cabinets for the installation of wiring and equipment.

B. Related work specified in other section:

1. Electrical: Section 26 00 00
2. Panelboards: Section 26 24 16
3. Enclosed Switches and Circuit Breakers: Section 26 28 16
4. Control Voltage Electrical Power Cables: Section 26 05 23

1.3 QUALITY ASSURANCE

A. Source Quality Control: Tests to meet applicable Underwriters' Laboratories, Inc. Standards.

B. Reference Standards:

1. Underwriters' Laboratories, Inc. applicable Standards.
2. National Electrical Code.

C. Design Criteria: National Electrical Manufacturer's Association construction types based on environment.

1. Indoor: NEMA Type 1
2. Outdoor: NEMA Type 3R

1.4 SUBMITTALS

A. Shop Drawings shall include dimensions, knockout sizes and locations, material types and gauges, finishes, and installation methods.

B. Certificates shall include labels of Underwriters' Laboratories, Inc., and National Electrical Manufacturer's Association affixed to each item.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

1. Square D

2. General Electric/ABB

2.2 MATERIALS

A. For Panelboards:

1. Same manufacturer as panelboard, boxes of code gauge steel, welded with edges turned to receive trim, and galvanized.
2. Trim and doors No. 12 gauge steel minimum, hinged door, flush tumbler lock and catch keyed alike throughout the work, factory enamel finish, suitable for field color coat.
    a. Flush: Overlap minimum 3/4 inches top, bottom, and sides.
    b. Surface: Same size as cabinet.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine structure to which cabinets are to be secured for defects which affect the execution and quality of work.

B. Do not start work until defects are corrected.

3.2 PREPARATION

A. Carefully measure and lay out exact locations.

B. Provide supports.

3.3 INSTALLATION

A. Provide cabinets where indicated and where necessary.

B. Provide flush type in finished areas centered in paneling and other Architectural features.

C. Provide surface type in equipment rooms, above accessible finished ceilings, and in crawl spaces.

D. Install lighting and power cabinets with tops 6 feet 6 inches above finished floor.

E. Install cabinet trim and doors straight and plumb.

3.4 CABINET IDENTIFICATION

A. Cabinets for all panelboards, switchboards, disconnect switches, transformers, motor starters, and electrical equipment furnished shall be provided with engraved phenolic lamacoid plastic name plates with 1/2 inch block engraving.

B. Name plates shall give equipment designation as scheduled on the drawings, circuit number designation, and voltage and phase of service.

3.5 ADJUSTMENT AND CLEANING

A. Adjust trims and doors for vertical and horizontal alignment.

B. Clean surfaces to be painted.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included: Provide wiring devices and cover plates for outlets designated to receive them.

B. Related work specified in other section:

1. 26 00 00 Electrical
2. 26 05 33 Boxes for Electrical Systems

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. U.L. 20 - General Use Snap Switches.

B. U.L. 498 - Attachment Plugs and Receptacles.

C. NEMA WD-1 General Color Requirements for Wiring Devices.

D. NEMA WD-6 Configurations for Specific Purpose Plugs and Receptacles.

E. Federal Specification WS-896 Switches, Toggle, Flush mounted.

F. Federal Specification WC-596 Connector, Electrical Power.

1.5 SUBMITTALS

A. Samples: Provide samples upon specific request for typical NEMA devices.

B. Product Data: If materials are by manufacturers other than those specified, submit manufacturer's product data describing materials and electrical ratings.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver devices and cover plates in manufacturer’s sealed unopened packages and protect from the introduction of dust and moisture.

B. Do not install wiring devices and cover plate until adjacent finishes are complete and the area has been cleaned to a dust free dry environment.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with at least ten years experience in the manufacture of similar equipment.

B. All wiring devices on the project shall be of the same manufacturer where rated 50 amperes or less.

C. Acceptable manufacturers:

1. Leviton.
2. Hubbell.
3. Pass & Seymour.
4. Cooper/ Arrow Hart

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless noted otherwise, wiring devices shall be standard industrial grade devices, gray color, with Type 302 stainless steel covers.

B. Where specifically noted on the drawings or required by the Architect, wiring devices in finished areas shall be Decora commercial grade devices, white color, with commercial grade thermoplastic matching cover plate.

C. Where required by the National Electrical code or local codes and ordinances, receptacles shall be commercial grade GFCI type, matching color with other wiring devices in the area, with matching polycarbonate cover plate.

2.2 INDUSTRIAL GRADE DEVICES

A. Shall be equal to the devices listed below.

B. Switches

1. Single pole wall toggle, Leviton 1221-2. P&S PS20AC1.
2. Three way wall toggle, Leviton 1223-2. P&S PS20AC3.
3. Four way wall toggle, Leviton 1224-2. P&S PS20AC4.
4. Single pole key toggle, Leviton 1221-2KL. P&S PS20AC1KL.
5. Three way key toggle, Leviton 1223-2KL .P&S PS20AC3KL.
6. Four way key toggle, Leviton 1224-2KL. P&S PS20AC4KL.

C. Straight Blade Receptacles

1. 125V, 20A, 5-20R, Simplex, Leviton 5361, P&S 5361.
2. 125V, 20A, 5-20R, Duplex, Leviton 5362, P&S 5362.

D. Locking Type Receptacles

1. 125V, 20A, L5-20R, Simplex, Leviton 2310. P&S L520R.
2. 250V, 20A, L6-20R, Simplex, Leviton 2320. P&S L620R.

E. Isolated Ground Receptacles

1. 125V, 20A, 5-20R, Duplex, Industrial grade, Leviton 5362-IG. P&S 1G5362.

F. GFCI Receptacles

1. 125V, 20A, 5-20R, Duplex, Commercial Grade, Leviton 7599. P&S 1595.

2.3 WEATHER RESISTANT DEVICES

A. Where noted on the drawings or located exterior to the building, wall switches shall be provided with die cast zinc weatherproof, gasketed cover plate with NEMA 3R classification in wet locations.

B. Where noted on the drawings or located exterior to the building, wall receptacles shall be provided with die cast zinc weatherproof gasketed cover plates with NEMA 3R classification, listed for in use unattended plugs in wet locations.

2.4 MOTOR RATED SWITCHES

A. Fractional horsepower motors with internal overload protection shall be provided with double pole or three pole manual motor starting switches equal to Leviton MS series.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Align wiring device covers vertically and horizontally and assure flush fit to wall surface.

B. Surface mounted devices in cast ferrous boxes shall be furnished with stamped steel galvanized face plates.

3.2 IDENTIFICATION

A. Each receptacle shall be provided with a permanently affixed name plate giving the panelboard and branch circuit number supplying the outlet.

B. Identification shall be on the inside or outside of the cover plate as directed by the Architect.

C. Manual Motor Rated Switches shall be provided with permanently attached engraved phenolic name plates giving the panel and branch circuit source of supply and the name of the device controlled.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for Coordination of work with other portions of the work.

1.2 DESCRIPTION

A. Work Included: Provide low voltage fuses for overcurrent protection in fusible devices.

B. Related Work specified in other sections:

1. Electrical: Section 26 00 00
2. Panelboards: Section 26 24 16
3. Enclosed Switches and Circuit Breakers: Section 26 28 16

1.3 QUALITY ASSURANCE

A. The equipment provided shall meet the requirements of the National Electrical Code and local codes and ordinances.

B. The equipment provided shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCE STANDARDS

A. NEMA FU1 Low Voltage Cartridge Fuses

B. UL 248 Low Voltage Fuses

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's bulletins, and minimum melting and total clearing time charts for each type of fuse.

1.6 JOB CONDITIONS

A. Deliver fuses to the project in the manufacturers new unopened shipping containers.

B. Store fuses in a clean, dust free, cool environment until required for installation to energize equipment.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years experience with the manufacture of similar equipment.

B. Acceptable Manufacturers

1. Bussman
2. Littlefuse

3. Ferraz - Shawmut

1.8 WARRANTY

A. Fuses shall be warranted to be in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 FUSES - 600A AND BELOW

A. All fuses shall have a separate overload and short-circuit elements. Fuses shall incorporate a spring activated thermal overload element that has a 284 degrees Fahrenheit melting point alloy.

B. The fuses shall have time-delay capabilities in accordance with UL standards for Class RK1, J, or CC fuses and an interrupting rating of 300,000 amperes RMS symmetrical, listed by a nationally recognized testing laboratory.

C. Peak let-through currents and I^2t let-through energies shall not exceed the values established by UL for Class RK1 or J fuses.

2.2 MOTOR CIRCUITS

A. The fuses shall be applied for all motors protected by properly sized overload relays:

1. Class RK1 fuses shall be installed in ratings of 130%, or 150% for Class J fuses, of motor full-load current (or next size larger if this does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuses may be sized at 175% of the motor full-load current, or the next standard size larger if 175% does not correspond to a standard fuse size.
2. Class L fuses shall be installed in ratings of 175% of motor full-load current (or next size larger if this does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuses may be sized up to 300% (or next size smaller).
3. Class CC fuses shall be installed in ratings of 200% of motor full-load current (or next size larger if this does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuses may be sized up to 400% (or next size smaller).
4. Fuses shall be tested and have documentation verifying compliance of Type 2 protection requirements for motor starters per UL508E or IEC 60947-4 for motor controllers.

2.3 SUPPLEMENTARY - LIGHT FIXTURE PROTECTIVE FUSES

A. Fluorescent fixtures shall be protected by “BUSSMANN® GLR or GMF Fuses in HLR Holders. These fixtures shall have individual protection on the line side of the ballast. A fuse and holder shall be mounted within, or as part of, the fixture. Size and type of fuse to be recommended by this fixture manufacturer.

B. All other ballast-controlled light fixtures shall be protected by BUSSMANN® KTK or FNQ Fuses in HEB, HEX, HEY, HPF, or HPS Holders. These fixtures shall have individual protection on the line side of the ballast. Fuse and holder shall be mounted in a location convenient for changing fuses. Holder shall be mounted in protected location or be an in-line waterproof holder (HEB, HEX, or HEY). Size and type of fuse to be recommended by the fixture manufacturer or as indicated on plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment for the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed.

B. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleansing, tightening, and review of all electrical connections and inspection of all grounding conductors.

3.2 SPARES

A. In addition to fuses consumed during testing, furnish 10%, but not less than three of each, of each size and type fuse used for the project, and store in spare fuse cabinet.

B. Provide Bussmann SFC spare fuse cabinet in main electrical room.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included: Provide disconnect switches and enclosed circuit breakers for branch circuit, motor circuits, and items of equipment.

B. Related work specified in other sections:

1. Division 23
2. 26 00 00 Electrical
3. 26 28 13 Fuses

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. UL 50 Cabinets and Boxes

B. UL 98 Enclosed and Deadfront Switches

C. UL 489 Molded Case Circuit Breakers

D. UL 977 Fused Power Circuit Devices

E. NEMA AB1 Molded Case Circuit Breakers and Molded Case Switches

F. NEMA KS1 Enclosed Switches

1.5 SUBMITTALS

A. Submit shop drawings including:

1. Enclosure outline drawings and dimensions.
2. Nameplate schedule.
3. Assembly ratings including:

a. Main lug ratings and location.
b. Voltage ratings.
c. Short circuit ratings.

4. Conduit entry and exit locations, dimensions, and knock-outs.
5. Cable terminal sizes.
6. Fuse types and ratings.
7. Manufacturer's literature describing circuit breakers and trip units.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and off loaded in accordance with the manufacturer's published instructions.

B. Upon arrival, inspect equipment for damage insured in shipping.

C. Store and protect equipment from moisture and dust by storing in a clean, dry, heated space. Provide additional heavy plastic cover to protect the equipment and components. Provide auxiliary heating in the sections in accordance with the manufacturer's recommendations.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years experience with the manufacture of similar equipment.

B. Acceptable Manufacturers:

1. Square D Company.
2. General Electric/ABB

1.8 WARRANTY

A. The equipment shall be warranted to be in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Enclosed Switches

1. Provide enclosed switches where indicated on the drawings or required by NEC.
2. Switches shall be NEMA Type HD, heavy duty, rated 600 volts, with quick-make, quick break switch units and external operator, rated 100,000 A.I.C.
3. Switches shall be fused or unfused as shown on the drawings and as required by NEC, capacity and number of poles as indicate don the drawings.
4. Enclosures shall be provided with interlocks to prevent opening the enclosure without first opening the switch and to prevent operating the switch with the enclosure open.
5. Enclosures shall be provided with a means for pad locking in the open position.
6. Enclosures shall be provided with an equipment grounding lug.
7. Enclosures for use on four wire shall be provided with an insulated neutral bus.
8. Line side and load side terminals shall be provided with insulating cover to prevent accidental contact.
9. Indoor locations shall be provided with NEMA Type 1 Enclosures.
10. Outdoor locations shall be provided with NEMA Type 3R Enclosures and water tight threaded hubs for conduit entry.

B. Enclosed Circuit Breakers

1. Provide enclosed circuit breakers or molded case switches where indicated on the drawings or required by the NEC.
2. Circuit breaker for rating 250 amperes or less shall be thermal magnetic molded case circuit breakers.
3. Circuit breakers 300 amperes through 1200 amperes shall be electronic trip, microprocessor based, true RMS sensing, with adjustable, defeatable instantaneous pickup.
4. Molded case switches shall be non-automatic with no over current trip function.

5. Units shall be 600 volt or 250 volt as required and unless noted otherwise shall be 42,000 A.I.C.
6. Enclosures shall be provided with a means for pad locking in the open position.
7. Enclosures shall be provided with and equipment ground bus.
8. Enclosures for use on four wire systems shall be provided with an insulated neutral bus.
9. Line side and load side terminals shall be provided with insulating covers to prevent accidental contact.
10. Indoor locations shall be NEMA Type 1 Enclosures.
11. Outdoor locations shall be NEMA Type 3R enclosures and watertight hubs for threaded conduit entry.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect building structure to which disconnects are to be secured for defects which affect the execution and quality of work.

B. Do not start work until defects are corrected.

3.2 PREPARATION

A. Carefully measure and lay out exact locations maintaining working clearances required by the National Electrical Code.

3.3 INSTALLATION

A. Provide disconnects where indicated and where required by the National Electrical Code and all equipment where integral disconnects are not provided by the manufacturers.

B. Provide disconnects mounted to building structure ahead of flexible conduit final connection to each fan powered terminal box.

C. Install within sight of equipment served.

D. Provide final connection to equipment served.

E. Provide engraved lamicoid name plate secured to cabinet with designation of equipment served, operating voltage, and circuit designation.

END OF SECTION

SECTION 26 43 13

SURGE SUPPRESSION DEVICES

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Provide low voltage surge suppression devices where shown on the drawings.

B. Related work specified in other sections

1. 26 00 00 Electrical
2. 26 05 19 Low Voltage Electrical Power Conductors and Cables
3. 26 05 32 Raceways
4. 26 24 13 Circuit Breaker Distribution Switchboards
5. 26 24 16 Panelboards

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

1.4 REFERENCED STANDARDS

A. UL 1449 - 3rd Edition - Surge Protective Devices

B. UL 1283 - Electromagnetic Interference Filters

C. ANSI C62.41 - Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits

D. ANSI C62.45 - Guide for Surge Testing for Equipment Connected to Low Voltage AC Power Circuits

E. IEEE 1100 - Emerald Book

F. NFPA 70 - National Electric Code

G. NEMA LS1 - Low Voltage Surge-Protection Devices

1.5 SUBMITTALS

A. Submit Shop Drawings Including:

1. Dimensions and weight of enclosure.
2. Conduit entry locations and knockouts.
3. Wiring diagram showing field connections.
4. Manufacturer’s recommended wire and breaker sizes.
5. Internal wiring diagram illustrating all modes of protection.
6. Internal functional block diagram.

B. Documentation for UL 1449 Listing verifying

1. Short Circuit Current rating (SSCR)
2. Voltage Protection Ratings (VPR)
3. Maximum Continuous Operating Voltage (MCOV)
4. I-Nominal Rating (I-n)
5. Type 1 Device Listing

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be included and off loaded in accordance with the manufacturer's published instructions.

B. Upon arrival, inspect equipment for damage incurred in shipping.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

D. Conform to NEMA PB2 service conditions during and after installation of panelboards.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years experience in the manufacture of similar equipment.

B. Acceptable Manufacturers:

1. Square D Company.
2. Eaton.
3. Current Technology.
4. Advanced Protection Technologies.

1.8 WARRANTY

A. The equipment shall be warranted to be in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 RATINGS

A. The Short Circuit Current Ratings (SCCR) shall be 200 KAIC without requiring an upstream protective device.

B. The Voltage Protection ratings (VPR) shall not exceed the following values:

C. For 120/208 volt systems, 700 volts L-N, L-G, N-G and 1200 volts L-L.

D. For 277/480 volt systems, 1200 volts L-N, L-G, N-G and 1800 volts L-L.

E. The Maximum Continuous Voltage Rating (MCOV) shall be not less than 115% of the nominal system operating voltage.

F. The I-Nominal rating shall be not less than 20 KA.

G. The units shall have not more than 10% deterioration or degradation of the VPR due to repeated surges.

H. The attenuation of the EMI/RF1 filter shall be a minimum of -50dB at 100KHz in accordance with UL1283.

2.2 OVERCURRENT PROTECTION

A. The unit shall contain thermally protected MOV's. The thermal protection element shall disconnect the MOV's from the system in a fail safe manner.

2.3 SERVICE DISCONNECT

A. Where SPD's are connected directly to a panelboard or switchboard bus without a feeder breaker or switch, the SPD shall be provided with an integral service disconnect.

2.4 SPD TYPE

A. All SPD's connected on the line side of the service disconnecting means shall be Type 1.

B. All SPD's connected on the load side of the service disconnecting means shall be Type 1 or Type 2.

2.5 ACCESSORIES

A. Surge counter with battery backup and manual reset button shall be provided.

B. Visible indication of proper operation shall be provided.

C. An audible alarm and dry contact alarm shall be provided to signal when any module has reached end of life condition.

2.6 ENCLOSURES

A. SPD's installed interior to the building shall be provided with NEMA 1 Enclosures.

B. SPD's installed exterior to the building or subject to the elements shall be provided with NEMA-4 Enclosures.

PART 3 - EXECUTION

3.1 PREPARATION

A. Carefully measure and lay out exact locations of TVSS in conference with the Engineer.

B. Assure that TVSS may be installed without adversely affecting the integrity and appearance of the building structure and with the clearances required by the National Electrical Code.

3.2 INSTALLATION

A. Provide supports to the building structure, independent of raceways.

B. Install tops of cabinet at 6 feet, 6 inches, above finished floor where possible.

C. Install ground connection as indicated in Grounding specifications.

D. Provide 3 pole 60 amp breaker to serve unit when required for branch circuit panelboard applications.

E. Provide Identification:

1. Engraved, lamacoid plastic name plate, giving panelboard designation being protected.

F. Lead length from terminal of circuit breakers shall not exceed 12".

END OF SECTION

SECTION 26 51 01

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included: Provide LED lighting fixtures and accessories for interior illumination of the building.

B. Related work specified in other Sections:

1. 26 00 01 General Provisions
2. 26 05 19 Low Voltage Electrical Power Conductors and Cables
3. 26 05 29 Hangars and Supports for Electrical Systems
4. 26 05 32 Raceways
5. 26 05 33 Boxes for Electrical Systems
6. 26 09 26 Occupancy Sensor Lighting Controls

1.3 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

C. Laboratory Testing: Photometric testing shall be by Independent Testing Laboratories, Inc., based on Illuminating Engineering Society published procedures, and shall include candlepower distribution tabulation and zonal cavity coefficient of utilization tabulation.

1.4 REFERENCE STANDARDS

A. Underwriters' Laboratories No. 57 - Fixtures, Electric Lighting.

B. Underwriters’ Laboratories No. 924 - Emergency Lighting and Power Equipment.

C. Underwriters’ Laboratories No. 1598 - Luminaires

D. Underwriters’ Laboratories No. 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces

1.5 SUBMITTALS

A. Submit manufacturer's literature giving materials, finishes, dimensions, coefficients of utilization, and lamp types for each fixture which is the product of one of the listed acceptable manufacturers.

B. Submit large scale shop drawings and copies of independent testing laboratory test report, along with manufacturer's literature for each fixture which is the product of any manufacturer not listed as acceptable.

C. Submit samples of fixtures upon specific request.

D. Certificates: Labels of Underwriters' Laboratories, Inc.; affixed to each item of material.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be included and off loaded in accordance with the manufacturer’s published instructions.

B. Upon arrival, inspect equipment for damage incurred in shipping.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.7 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years’ experience with the manufacturer of similar equipment.

B. Listed in schedule and with materials.

1.8 WARRANTY

A. The equipment shall be warranted to be in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lighting Fixtures:

1. Fixtures shall be of the lighting fixture types scheduled on the drawings according to the letter type designations on the plans.
2. If letter type designation is omitted from any fixture shown on the plans, provide the same fixture type as employed in rooms of similar usage.
3. Where manufacturer’s model numbers are used to describe fixtures, the intent is to establish the kind and quality of the fixture. The Contractor is responsible for examining the drawings to establish correct ordering information for each fixture including but not limited to voltage for the branch circuit supply, ceiling trim and mounting means for the ceiling material.

B. Exit Signs:

1. Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

C. LED Source Package Lamps:

1. LED fixtures, source packages, arrays or modules and power supplies shall be UL 1598 and 2043 listed.
2. LED source packages, arrays or modules and power supplies shall be tested in accordance with LM-79/LM80.
3. LED light source packages, arrays or modules shall be tested in accordance with LM-80 depreciation test and L70 rated life result shall be a minimum of 50,000 hours.
4. LED lamp color temperature of 4000K with minimum 80% CRI is required for LED lamps. Lamp lumen minimum values as scheduled.
5. Luminaire power factor shall be minimum 90%.
6. LED fixtures, source packages, arrays or modules and power supplies shall be Design Lights Consortium (DLC) qualified.

D. LED Power Supplies/Drivers:

1. LED power supplies shall operate LEDs within the current limit specification of the manufacturer.
2. Shall operate from 60 Hz input source and have input power factor >90% and a minimum efficiency of 70% at full rate load of the driver.
3. Shall have short circuit and overload protection.
4. Shall have a minimum starting temperature of 0°F and a maximum case temperature rating of at least 70°F.
5. Power supply output shall be regulated to ±5% across published load range.
6. Shall have as Class A sound rating.
7. Shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.
8. Shall contain no PCBs.
9. Shall carry a five (5) year minimum warranty from date of manufacturer against defects in materials or workmanship, including a replacement for operation at or below the maximum case temperature specification. For LED lamps and internal power regulation components for defects resulting in a fixture lumen depreciation >30%.
10. Dimmable power supplies shall allow the light output to be maintained at the lowest control setting (prior to off) without dropping out.

E. Emergency Lighting Units with Battery Packs:

1. Self-contained units complying with UL 924.

a. Battery: Sealed, maintenance-free, lead-acid type.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

F. LED Source Package Lamps:

1. LED fixtures, source packages, arrays or modules and power supplies shall be UL 1598 and 2043 listed.
2. LED source packages, arrays or modules

G. Lighting Fixture Support Components:

1. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
2. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
3. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
4. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
5. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
6. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
7. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

H. Accessories: Manufacturers' standard mounting ring, trim flanges, hanger bars, spacers, supports, plaster frames of non-ferrous material or cadmium plated steel. Do not use painted steel plaster frames.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect Architectural drawings and specifications, including ceiling alternates, to determine ceiling material to be installed.
B. Inspect Architectural reflected ceiling plans.
C. Inspect installed ceiling components and pole bases for defects affecting the quality and execution of work.

3.2 PREPARATION

A. Verify ceiling material, type, support method and alignment.
B. Layout exact locations of fixtures in accordance with reflected ceiling plans, fixtures' and switches' outlet boxes and supports, and poles and standard bases.
C. Provide specified outlet boxes and conduit system for the light fixtures including conduit support system.
D. All lighting fixtures shall be supported from building structure. Do not support lighting fixtures from the ceiling system. Fixtures shall be supported by supplementary hangars located within 6 inches of each corner, or supported independently from the structure. Do not support lighting fixtures from other building systems located above the ceiling such as fire sprinkler piping, HVAC piping, plumbing piping, equipment or ductwork.

3.3 INSTALLATION

A. Provide lighting fixtures, control systems and wiring.

B. If designation omitted on drawings, provide same type fixtures employed in rooms of similar usage.

C. Provide spacers for fixtures mounted on low density ceiling material.

D. Provide plaster frames for recessed fixtures in plaster or gypboard ceilings.

E. Install fixtures in and on acoustical tile ceilings in alignment with tile joints.

F. Install fixtures in gypsum board ceilings to recess in the space available between structural members where the ceiling is installed tight against the structure.

G. Install in accordance with manufacturer's instructions, submittal data, and details on the drawings.

3.4 ADJUSTMENT AND CLEANING

A. Adjustment: Adjust lamp positions for desired effects. Align fixtures with building walls and tile joints.

B. Cleaning: Remove dirt, grease, and foreign materials from fixtures. Remove fingerprints, smudges, and dirt from fixture's lenses and lamps.

3.5 LIGHTING FIXTURE SCHEDULE

A. Reference drawings for Lighting Fixture Schedule.

END OF SECTION

SECTION 26 51 02

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related work specified in other Sections:

1.	26 00 00	Electrical
2.	26 05 19	Low Voltage Electrical Power Conductors and Cables
3.	26 05 26	Grounding and Bonding for Electrical Systems
4.	26 05 29	Hangars and Supports for Electrical Systems
5.	26 05 32	Raceways
6.	26 05 33	Boxes for Electrical Systems

1.3 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4, for this project.

1.4 QUALITY ASSURANCE

A. The equipment supplied and installed shall meet the requirements of the National Electrical Code and all applicable local codes and ordinances.

B. All equipment supplied shall be Underwriter’s Laboratories Inc. listed and so labeled.

C. Laboratory Testing: Photometric testing shall be by Independent Testing Laboratories, Inc., based on Illuminating Engineering Society published procedures, and shall include candlepower distribution tabulation and zonal cavity coefficient of utilization tabulation.

1.5 REFERENCE STANDARDS

A. Underwriters' Laboratories No. 57 - Fixtures, Electric Lighting.

B. Underwriters' Laboratories No. 924 - Emergency Lighting and Power Equipment.

C. Underwriters' Laboratories No. 1598 - Luminaires

1.6 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with Ballasts, including energy-efficiency data.
6. Lamps, including life, output, and energy-efficiency data.
7. Materials, dimensions, and finishes of poles.
8. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
9. Anchor bolts for poles.
10. Manufactured pole foundations.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
3. Wiring Diagrams: Power and control wiring.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

D. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

G. Certificates: Labels of Underwriters' Laboratories, Inc.; affixed to each item of material.

1.7 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be included and off loaded in accordance with the manufacturer's published instructions.

B. Upon arrival, inspect equipment for damage incurred in shipping.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.8 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years' experience with the manufacturer of similar equipment.

B. Listed in schedule and with materials.

1.9 WARRANTY

A. The equipment shall be warranted to be in proper working order for a period of one year following the date of final acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lighting Fixtures:

1. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
2. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
3. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
4. Fixtures shall be of the lighting fixture types scheduled on the drawings according to the letter type designations on the plans.
5. If letter type designation is omitted from any fixture shown on the plans, provide the same fixture type as employed in rooms of similar usage.
6. Where manufacturer’s model numbers are used to describe fixtures, the intent is to establish the kind and quality of the fixture. The Contractor is responsible for examining the drawings to establish correct ordering information for each fixture.

B. Poles and Support Components, General Requirements:

1. Structural Characteristics: Comply with AASHTO LTS-4.
   a. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
   b. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   c. Materials: Shall not cause galvanic action at contact points.
   d. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   e. Anchor-Bolt Template: Plywood or steel.
4. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. LED Source Package Lamps:

1. LED fixtures, source packages, arrays or modules and power supplies shall be UL 1598 and 2043 listed.
2. LED source packages, arrays or modules and power supplies shall be tested in accordance with LM-79/LM80.
3. LED light source packages, arrays or modules shall be tested in accordance with LM-80 depreciation test and L70 rated life result shall be a minimum of 50,000 hours.
4. LED lamp color temperature of 4000K with minimum 80% CRI is required for LED lamps. Lamp lumen minimum values as scheduled.
5. Luminaire power factor shall be minimum 90%.
6. LED fixtures, source packages, arrays or modules and power supplies shall be Design Lights Consortium (DLC) qualified.

C. LED Power Supplies/Drivers:

1. LED power supplies shall operate LEDs within the current limit specification of the manufacturer.
2. Shall operate from 60 Hz input source and have input power factor >90% and a minimum efficiency of 70% at full rate load of the driver.
3. Shall have short circuit and overload protection.
4. Shall have a minimum starting temperature of 0°F and a maximum case temperature rating of at least 70°F.
5. Power supply output shall be regulated to ±5% across published load range.
6. Shall have as Class A sound rating.
7. Shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.
8. Shall contain no PCBs.
9. Shall carry a five (5) year minimum warranty from date of manufacturer against defects in materials or workmanship, including a replacement for operation at or below the maximum case temperature specification. For LED lamps and internal power regulation components for defects resulting in a fixture lumen depreciation >30%.
10. Dimmable power supplies shall allow the light output to be maintained at the lowest control setting (prior to off) without dropping out.

D. Steel Poles:

1. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
3. Steel Arms: Material and finish same as pole.
4. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
5. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
6. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   b. 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.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

B. Adjust luminaires that require field adjustment or aiming. Aiming must occur at night with architect present.

C. Clean fixtures prior to Substantial Completion.

1.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

D. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet.

E. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

F. Install outdoor lighting units as indicated in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards, and with recognized industry practices to ensure that lighting units fulfill requirements.

G. Use belt slings or rope (not chain or cable) to raise and set finished poles and standards so as to protect pole and luminaire finishes.

H. Set poles and standards plumb. Support adequately during anchoring to foundations.

I. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling where indicated.

J. Provide two (2) 1" spare conduits stubbed out from each pole foundation for security system requirements.

3.2 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.3 CORROSION PREVENTION

A. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

C. 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.

3.6 LIGHTING FIXTURE SCHEDULE

A. Reference drawings for Lighting Fixture Schedule.

END OF SECTION

SECTION 26 51 05

LIGHTING CONTROLS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Comply with Division 1 - General Requirements and related documents.

B. Comply with all other Division 26 sections as applicable.

C. Refer to other Divisions for coordination of work with other portions of work.

1.2 DESCRIPTION

A. Work Included: Provide a distributed, low voltage lighting control system with networked devices.

B. Related work specified in other Sections:

1. 26 00 00 Electrical
2. 26 05 19 Low Voltage Electrical Power Conductors and Cables
3. 26 95 32 Raceways
4. 26 05 33 Boxes for Electrical Systems
5. 26 51 01 Interior Lighting

1.3 QUALITY ASSURANCE

A. Factory Assembly: All system components shall arrive at the job site completely pre-wired and ready for installation, requiring only the connection of lighting circuits and network terminations. All connections shall be made to clearly and permanently labeled termination points. Systems that require field assembly shall not be acceptable.

B. Component Testing: All system components and assemblies shall be individually tested prior to assembly. Once assembled, all finished products shall be tested for proper operation of all control functions per specifications prior to shipment.

C. NEC Compliance: All system components shall comply with all applicable sections of the National Electrical Code (NEC) as required.

D. NEMA Compliance: All system components shall comply with all applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

E. UL Approval: All applicable equipment shall be tested to and listed under UL standard 508 and shall bare labels to indicate compliance. Lighting control relays shall be tested to UL standard 508 for both safety and endurance. System listed other ETL or other UL sections shall provide documentation proving compliance with UL standard 508.

1.4 SUBMITTALS

A. Submittals shall include, but not be limited to, the following:

1. Product data on all lighting control system components and accessories.
2. Reflected ceiling plan drawings showing specific locations of occupancy sensors for lighting control including lines delineating sensor effective range, with and without furniture system partitions, sensor type, sensor mounting, and other pertinent data to allow evaluation of the proposed system.
3. Wiring diagrams for occupancy sensors, related control units, and override switches including an overall system riser diagram.

4. Make submittals in accordance with Division 01.
5. Submit factory approved lighting controls layout showing all devices and proposed devices locations.

1.5 DELIVERY STORAGE AND HANDLING

A. Deliver devices and cover plates in manufacturer's sealed unopened packages and protect from the introduction of dust and moisture.

B. Do not install sensors and cover plate until adjacent finishes are complete and the area has been cleaned to a dust free dry environment.

1.6 MANUFACTURER

A. The equipment shall be the product of a manufacturer with a minimum of ten years experience with the manufacture of similar equipment.

B. Acceptable Manufacturer

1. Acuity
2. Hubbell
3. Lutron
4. Siemens
5. Wattstopper

1.7 WARRANTY

A. Provide a five year parts and one year labor warranty. Warranty coverage shall begin at the time of Project Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Summary:

1. The lighting control system specified in this section shall occupancy sensor-based and manual lighting control
2. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers will be capable of "dimming lights to off".
3. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function independently.
4. The system shall not require any centrally hardwired switching equipment.

B. System Requirements:

1. System must interface directly with intelligent LED luminaires such that only plenum rated CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see Networked LED Luminaire section).
2. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
3. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
4. Devices within a lighting control zone shall be connected with plenum rated CAT-5e low voltage cabling in any order.

2.2 Digital Room Controller

A. As indicated and where shown on the plans, install room controllers to control the quantity of lighting and plug loads required.

B. Room controllers shall provide 0 - 10 volt dimming capability for the required number of lighting loads.

C. Room controllers shall integrate the functionality of connected control components including wall switch stations, occupancy sensors and daylight sensors to provide the required sequence of operation for the space.

D. Room controllers and associated room control components shall operate in a totally stand alone mode and not require the use of a network, software, computer or server for local control and time based functions.

E. Functional:

1. Provide an integral pushbutton and LED indicator for each load for status and to allow operation of the relays and dimmers for testing and verification without requiring other control devices to be connected.
2. The room controller shall have a default operation providing an automatic logical sequence of operation for each load as the room control devices are plugged into the Smart Port connectors.
3. Default operation for occupancy sensors shall be automatic on, automatic off for all loads.
4. Upon connection of a switch, the operation shall automatically change to manual on, automatic off (vacancy) mode for all loads.
5. Provide capability to convert each load independently to automatic on or vacancy mode using only the integral push buttons and LED indicators on the room controller.
6. When in vacancy mode, provide a 30 second grace period after an off during which automatic on shall be temporarily enabled.
7. It shall be possible to connect up to eight (8) room controllers together using Cat5 patch cables to provide configurations up to 16 switched and dimmed loads operating as a single zone.
8. Provide the following set up and configuration functions without the need for additional devices or software:

    a. Assign/reassign relays for control by wall switch station buttons
    b. Configure relays for occupancy or vacancy operation
    c. Assign/reassign dimmers to raise/lower switches
    d. Assign dimming channels for response to daylight sensor control
    e. Auto calibrate default daylight sensor sequence of operation
    f. Save preset scenes

2.3 Low Voltage Switch Stations

A. Low voltage digital wall switch stations shall be of the programmable type using plenum rated Cat5 cabling for connection to system smart port.

B. Stations shall have one to six buttons and provide lighting control functions as called out and shown on the plans.

C. All switches shall be single gang and be of the generic decorator style allowing easy ganging and use of a wide array of standard wall switch plate options.

D. Provide two RJ-45 ports per switch to allow for daisy chain connection of up to eight switches to each smart port.

E. Switch station color shall be white with white cover plates.

2.4 Occupancy / Vacancy Sensors

A. Occupancy sensors shall be ceiling or wall mounted and use dual technology (ultrasonic and passive infrared), ultrasonic and/or passive infrared (model specific) sensing technology as indicated.

B. Sensors shall be Class 2 and connect to any room controller smart port using a wiring adaptor and standard Cat5 patch cable.

C. Occupancy sensors shall be self adaptive and not require manual calibration after installation. Digital circuitry and logic shall automatically make adjustments to the sensitivity and time delay based on learned occupancy patterns and the environment in which the sensor is installed.

D. Sensors using both ultrasonic and passive infrared (dual technology) shall operate such that detection by both technologies is required to initiate occupancy and continued detection by either technology will maintain occupancy.

E. Up to four occupancy sensors may be connected to one room controller.

2.5 Emergency Lighting Interface

A. Where emergency lighting is to be controlled by the lighting control system, provide UL924 listed load control relays as necessary to insure that emergency lights are automatically turned full on upon loss of normal power to the area.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lighting controls as required and where indicated, in accordance with manufacturer's written instructions and project shop drawings, applicable requirements of NEC, and recognized industry practices to ensure that products serve intended function.

B. Sensor Design and Layout:

1. It shall be the equipment manufacturers'/ contractors' responsibility to provide the quantity of sensors required for complete and proper coverage without gaps within the range of coverage of controlled areas. Rooms shall have 100% coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room. The locations and minimum quantities of sensors shown on the Drawings are diagrammatic and indicate only rooms which are to be provided with sensors. The equipment manufacturer/contractor shall provide additional sensors if required to properly and completely cover the respective room. Proper judgment must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
2. Exact locations of control unit hardware boxes shall be based on observing good installation practice and shall be coordinated with other elements of the reflected ceiling plan. Control unit hardware shall be fully concealed.

C. Box Condition: Install low voltage lighting control devices only in electrical boxes which are clean, free from excess building material, debris, and similar matter.

D. Wiring:

1. All branch circuit wiring shall be installed in an approved raceway.
2. Low voltage wiring shall be installed in an approved raceway where concealed in inaccessible locations or exposed. Where low voltage wiring is concealed in accessible ceiling plenums, it may, with pre-approval from the Owner and Engineer, be routed without a raceway using air plenum rated cable.
3. All low voltage wiring shall be color coded and identified or tagged at terminals to assist with future maintenance.

E. Sensor Testing and Adjustment: At the time each sensor is installed, it shall be adjusted as follows:

1. Sensitivity shall be adjusted for proper occupant detection appropriate to the usage of the room.
2. Set time delay at approximately 6 minutes after setting in 30 second test to verify sensor/control unit operation.
3. Check indicator light of each sensor to verify that occupancy is being detected in the range desired.
4. Sensor operating frequencies shall be selected to select interference with other units in the vicinity as required.
5. Ensure that there are no obstructions which could block proper sensor coverage, thereby minimizing the sensor detection zone.
6. Occupancy sensors may be affected by various conditions in the room. It may be necessary for the Contractor to make adjustments, change the location or type of sensor to obtain proper operation in a specific room. The Contractor/equipment manufacturer shall have final responsibility for proper operation and coverage of the system in each room and should therefore make labor allowance for such changes and adjustments. The Contractor is also responsible for acquiring approval from Engineer for any changes or deviations from project specifications.

3.2 SPARES

A. Provide 10% spare sensors and switch packs of each type used on the project.

B. Deliver spares to the Owner at completion of project.

3.3 SYSTEM COMMISSIONING

A. The contractor shall provide lighting system functional testing per C408.3.1 of the 2015 International Energy Conservation Code. A lighting control system manufacturer’s representative shall be on site to assist the contractor during testing. Any deficiencies in the system’s performance shall be corrected immediately prior to issuing a final report.

B. All occupancy sensors shall be tested for location and functional acceptability.

C. Time switch controls shall be tested for the correct time, date and owners control schedule. Lighting on time switch controls shall be tested for on / off / dimming status.

D. Daylight responsive controls shall be tested for location and functional acceptability.

E. All building management system software, graphics, reporting and remote control shall be tested and accepted by the Owner prior to issuing the functional testing final report.

F. A final report certifying that the installed lighting controls meet documented performance criteria of section C405 of the 2015 International Energy Conservation Code shall be submitted to the Owner, Architect and Engineer for approval within 90 days from the date of receipt of the Certificate of Occupancy.

3.4 DEMONSTRATION/TRAINING

A. Upon completion of testing and adjustment, the Contractor shall demonstrate operation of the system to representatives of the Owner and Engineer.

B. The Contractors shall provide eight hours of instruction the Owner's personnel in proper maintenance, adjustment, and operation of the occupancy sensor lighting controls.

3.5 Project Closeout Documentation

A. Provide a factory published manual

1. Warranty
2. Technical support contact

3. Electronic manual

END OF SECTION

SECTION 26 52 00

EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Central Battery Systems Series CBM

1.2 REFERENCES

A. NFPA 101- Life Safety Code

B. NFPA 70 – National Electrical Code

C. UL 924 – Standards for Emergency Lighting & Power Equipment

1.3 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each physical component, in addition to wiring diagram for any “system” to be provided under this contract.

B. Product Data: Provide dimensions, ratings and performance data.

C. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation and installation of product.

D. Submit manufacturer’s operation and maintenance instructions for each product.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializes in manufacturing the emergency lighting products specified in this section with minimum five years experience.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 101 and NFPA 70 and applicable local codes.

B. Products: Listed and labeled as required by Underwriter’s Laboratories Standard for Safety UL 924, Emergency Lighting and Power Equipment, as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 CENTRAL BATTERY SYSTEMS

A. Manufacturers

1. Signtex Lighting, Inc: Series CBM
2. Engineer Approved Equals

B. System Description

1. Signtex Series CBM Central Battery System shall provide control and battery backup power for a minimum of 90 minutes to all emergency fixtures connected to the system, including exit signs, emergency lights, and night lights. As an option, all emergency lighting fixtures may operate in normal ON mode when building AC power is available, from a 24VDC power supply.
2. In addition to fixtures specifically designed for emergency lighting, any LED general lighting fixture may be converted to emergency operation by use of the Signtex Emergency Lighting Control Series ELC, operating at 24VDC supplied from the central battery system.

C. Construction and Operation

1. The power supply is to be a UPS system per NEC 700.12 (c) with storage batteries, charging system, automatic transfer switch and self-test switch with an LED indicator, providing uninterrupted output at 24VDC for loads as specified for at least 90 minutes in emergency operation. The Push to Test Switch and Diagnostic Status Indicator allow immediate update on battery condition and charger performance.
2. Maximum battery charge time shall be 12 hrs.
3. The equipment shall include automatic self-testing/self-diagnostic systems as mandated by **NFPA 101 (2012), Section 7.9.3 Periodic Testing of Emergency Lighting Equipment, Para 7.9.3.1.3 (1) for Computer-based, Self-Testing/Self-Diagnostic battery operated emergency lighting equipment.**
4. The system shall be capable of providing a report of the history of tests and failures by display on a built-in screen on the central battery enclosure.
5. A Monitoring and Reporting System (MARS) shall be capable of automatically creating and sending emails via internet to any designated address, containing fault reports and test result history as required.
6. The battery and charger system enclosure shall be a NEMA Type 1, UL 50 steel cabinet, for surface or optional recessed mount.
7. Maintenance on the batteries or other electronics for all emergency lighting equipment on one building floor can be performed without requiring access to the lighting fixtures, except for lamp failures.
8. The DC wiring output terminals in each CBS system shall have up to 8 circuits available for lighting devices.

D. Fixtures, Installation and Wiring

1. Refer to Lighting Fixture Schedule on plans for details. All fixtures shall be equipped with LED lamps.
2. Emergency lighting fixtures may include, but are not limited to: Signtex MOONLITE Series MLD (Recessed Downlight), MLW (Wall Mount), MOE (Exterior Wall Mount), MLS (Surface Mount Downlight), MUE (Exterior Mullion Mount), MAE (Exterior Wall Mount, MFP (Recessed Wall Mount Exterior Floor Proximity), MHE (Exterior/Interior Surface or Recessed Mount High Bay), or CVRE (Recessed light with moving doors). Exit signs may include Signtex Series RPR (Die Cast exit signs), CRS or CRR (Edge Lit exit signs), BLD (Thermoplastic Housing exit signs), or BLW (Die Cast Wet Location Exit signs).
3. In addition to the fixtures above, and LED general lighting fixture may be converted to emergency operation by installation of the Signtex Emergency Lighting Control Series ELC.
4. Branch circuits shall be wired with conductor sizes from #12 to #8 AWG. Flexible metal case (Type MC Class 1) cable is recommended for most applications, however provided applicable current limits are met, Class 2 (low voltage/current limited) wiring may be installed. Verify any specifications for wiring required by local codes.
5. The number of conductors required in any branch circuit shall be from 2 to 4, as required by the type of fixture and operation specifications. See Signtex Installation and Instruction Manuals for detailed requirements.
6. Verify that maximum run lengths meet manufacturer’s recommendations for voltage drop at the given load, per NEC 700.9.
7. In accessible ceiling areas, low voltage emergency power cabling can be installed on J-hooks or other similar means designed for use above accessible ceilings.
8. In exposed or non-accessible ceilings, emergency power cabling shall be installed in conduit.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation Procedures and Verification

1. The successful bidder shall review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.
2. The successful bidder shall install and connect the low voltage exit and emergency lighting system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.
3. The successful bidder shall coordinate the installation of the voltage exit and emergency lighting system components with other manufacturers fixtures, according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.
4. The successful bidder shall be responsible for testing of all low voltage network cable included in the bid. Bidder is responsible for verification of the following minimum parameters:

    a. Wiring Map for all low voltage lighting to all fixture.
    b. Length
    c. Size

B. Coordination with Owner's IT Network Infrastructure

1. The successful bidder is required to coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.

    a. The bidder shall provide to the manufacturer's representative all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.

C. Documentation and Deliverables

1. The installing contractor shall be responsible for documenting installed location of all networked devices, including networked luminaires. This includes responsibility to provide as-built plan drawing showing device address barcodes corresponding to locations of installed equipment.
2. The installing contractor is also responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floorplan software is provided as part of bid package:

    a. As-Built floor plan drawings showing device address locations required above. All documentation shall remain legible when reproducing\scanning drawing files for electronic submission.
    b. As-Built electrical lighting drawings (reflected ceiling plan) in PDF and CAD format. Architectural floor plans shall be based on as-built conditions.

        1) CAD files shall have layers already turned on/off as desired to be shown in the graphical floorplan background images. The following CAD elements are recommended to be hidden to produce an ideal background graphical image:

            a) Titleblock
            b) Text- Inclusive of room names and numbers, fixture tags and drawings notes
            c) Fixture wiring and homeruns
            d) Control devices
            e) Hatching or poché of light fixtures or architectural elements

        2) CAD files shall be of AutoCAD 2013 or earlier. Revit file overall floor plan views shall be exported to AutoCAD 2013.

3.2 SYSTEM STARTUP

A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed.

1. System start-up and programming shall include:
2. Verifying operational communication to Central Battery monitor.
3. Programming the Central Battery monitoring for owners information for notification.

B. Initial start-up and programming is to occur on-site.

3.3 PROJECT TURNOVER

A. System Documentation

1. Submit software database file with desired device labels and notes completed. Changes to this file will not be made by the factory.

B. Owner Training

1. Provisions for onsite training for owner and designated attendees to be included in submittal package.

END OF SECTION

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Structured cabling for voice and data

B. Grounding and Bonding

C. Cable Pathways

D. Cable management

E. Outfitting of communication equipment rooms

1.2 RELATED WORK SPECIFIED UNDER OTHER DIVISIONS

A. Foundations and pads required for equipment furnished under this Division

B. Field painting, except such painting as is required to maintain shop coat painting and factory finish painting.

C. Flashing of conduits into roofing and outside walls.

D. Heating, ventilating, and air conditioning equipment.

E. Electrical service to equipment rooms.

F. Cutting and patching for low voltage systems work, except for errors and omissions under this Division.

1.3 RELATED WORK - OWNER FURNISHED EQUIPMENT AND SYSTEMS

A. Computer workstations, servers, printers and other peripherals

1.4 QUALITY ASSURANCE

A. Contractor shall identify all types of quality control mechanisms they employ. Please list.

B. Perform work in accordance with contract documents.

C. All personnel performing the work of this Section shall be thoroughly familiar with the cabling methods set forth in the latest release of the BICSI TDMM (Building Industry Consulting Services International Telecommunications Distribution Methods Manuals).

D. Contractor’s RCDD shall review all required work prior to commencing. The Contractor’s RCDD shall oversee the installation and will have the end responsibility for the quality of the installation work performed. All submitted designs and or changes to the design shall be approved and signed off by the Contractor’s RCDD.

E. The installed cabling systems shall not generate nor be susceptible to any harmful electromagnetic emission, radiation, or induction that degrades cabling systems.

F. Expansion Capability: Unless otherwise indicated, provide spare positions in wall fields, cross connects, and terminal strips, and space in cable pathways to accommodate twenty (20) percent future growth in campus distribution and riser.

G. Backward Compatibility: The provided solution shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the permanent link and channel measures shall meet or exceed the lower channel's specified parameters.

H. Component Compliance: The provided solution's components shall each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent and channel, regardless of the fact that tests for permanent and channel ultimately meet required specifications.

I. Pre-installation inspection: Visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.

J. Test optical fiber cable while on reels. Use an optical time domain reflectometer (OTDR) to verify the cable length and locate cable defects, splices, and connector, including the loss value of each.

K. Test each pair of UTP cable for open and short circuits. Test results to be submitted to Owner.

L. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.

1.5 STANDARDS

A. The Contractor's performance of the Work shall comply with applicable federal, state and local laws, rules and regulations. The Contractor shall give required notices, shall procure necessary governmental licenses, permits, and inspections and shall pay without burden to The Owner, all fees and charges in connection therewith unless specifically provided otherwise. In the event of violation, the Contractor shall pay all fines and penalties, including attorney's fees and other defense costs and expenses in connection therewith.

B. Federal Communications Commission
   1. Equipment requiring FCC registration or approval shall have received such approval and shall be appropriately identified.

C. Codes, Standards and Ordinances
   1. Design, manufacture, test, and install telecommunications cabling networks per manufacturer's requirements and in accordance with NFPA-70 (National Electrical Code®), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following standards:
      a. NECA 1 – Standard for Good Workmanship in Electrical Construction, 2015
      b. ANSI/TIA Standards:
         1) ANSI/TIA-568.0-D – Generic Telecommunications Cabling for Customer Premises, 2015
         2) ANSI/TIA-568.0-D-1 –Generic Telecommunications Cabling for Customer Premises – Addendum 1, Updated References, Accommodation of New Media Types, 2017
         3) TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard, 2009 - Part 1: General Requirements, 2009
         4) TIA-568-C.1-1 - Commercial Building Telecommunications Cabling Standard, Addendum 1: Pathways and Spaces, 2012
         5) TIA-568-C.2 – Commercial Building Telecommunications Cabling Standard, 2009 - Part 2: Balanced Twisted Pair Cabling Components, 2009
         6) TIA-568-C.2-1 - Balanced Twisted Pair Cabling Components, Addendum 1: Specifications for 100 Next Generation Cabling, 2016
         7) TIA-568-C.2-1 - Balanced Twisted Pair Telecommunications Cabling and Components, Addendum 2: Additional Considerations for Category 6A Patch Cord Testing
         8) ANSI/TIA-568.3-D – Optical Fiber Cabling Components Standard, 2016
         9) ANSI/TIA-568.4-D - Broadband Coaxial Cabling and Components Standard, 2017
         10) ANSI/TIA-569-D – Telecommunications Pathways and Spaces, 2015
         11) ANSI/TIA-569-D-1 - Telecommunications Pathways and Spaces, Addendum 1: Revised Temperature and Humidity Requirements for Telecommunications Spaces, 2016
         12) ANSI/TIA-606-C – Administration Standard for Telecommunications Infrastructure, 2017
         13) ANSI/TIA-607-D – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, 2015
         14) ANSI/TIA-526.7-A – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, 2015
         15) ANSI/TIA-526.14-C – Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant, 2015

16) TIA-758-B – Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2012
17) ANSI/TIA-942-B – Telecommunications Infrastructure Standard for Data Centers, 2017
18) NFPA-70 – National Electrical Code, 2017
19) Install cabling in accordance with the most recent edition of BICSI® publications:
    a) BICSI – Telecommunications Distribution Methods Manual, 13th Edition
    b) BICSI – Cabling Installation Manual

c. Federal, state, and local codes, rules, regulations, and ordinances governing the Work, are as fully part of the specifications as if herein repeated or hereto attached. If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Owner's Representative in writing. Where the requirements of other sections of the specifications are more stringent than applicable codes, rules, regulations, and ordinances, the specifications shall apply.
d. American Society for Testing and Materials (ASTM): ASTM E. 814 – Standard Test Method for Fire Tests of Penetration Firestop Systems
e. Underwriters Laboratories, Inc. (UL): UL 1479 – Tests of Through-Penetration Firestop Systems
f. Americans with Disabilities Accessibility Guidelines, 2010.
g. Code of Federal Regulations, Title 29, Chapter XVII, Part 1910 (OSHA).
h. Uniform Building Code (UBC).
i. International Building Code (IBC).
j. Texas Department of State Health Services (TDSHS)
k. Applicable codes and directives of authorities having jurisdiction

1.6 COMPLETENESS OF WORK

A. The Contract Documents depict low voltage systems which are intended to be complete and functioning systems. All products, materials, labor, and programming necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the Contractor.

B. Catalog numbers referenced throughout this Division’s drawings and specifications are intended to convey a general understanding of the type of quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra charge shall be allowed because a catalog number is found to be incomplete or obsolete.

1.7 PRE-INSTALLATION CONFERENCE

A. Arrange and schedule pre-installation conference prior to beginning any work of this section Communications.

B. Agenda: Clarify questions in writing related to work to be performed, scheduling, coordination, etc. with consultant and/or project manager/Owner representative.

C. All individuals, who will be in an on-site supervisory capacity, shall be required to attend the pre-installation conference. This includes project managers, site supervisor and lead installers. Individuals who do not attend the conference will not be permitted to supervise the personnel that install, terminate, or test communications cables on the project. The Contractor’s RCDD that will oversee the installation is required to attend the pre-installation conference.

D. The manufacturer that will be providing the extended warranty is required to have a representative attend the pre-installation conference.

1.8 SEQUENCE AND SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and if accepted will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

D. Submit schedule for installation of equipment and cabling. Indicate delivery, installation, and testing for conformance to specific job completion dates. As a minimum, dates are to be provided for bid award, installation start date, completion of station cabling, completion of riser cabling, completion of testing and labeling, cutover, completion of the final punch list, start of demolition, Owner acceptance, and demolition completion.

1.9 SUBMITTALS

A. Comply with provisions of Division 01.

B. Produce Shop Drawings for section 271100 and 271500.

1.10 ALTERNATES, SUBSTITUTIONS AND CHANGE ORDERS

A. If a proposed alternate material is equal to or exceeds specified requirements, Contractor shall provide manufacturer's specifications in writing for written approval prior to purchase and installation of proposed materials. The proposed material substitution shall not void or change manufacturer's warranty.

B. Contractor shall provide a complete cabling infrastructure according to these written specifications and drawings. If the Owner changes the scope of work to be performed by the Contractor, it shall be in writing. Contractor shall respond to these changes with a complete material list, labor, and taxes in writing presented to the Owner for approval. Contractor shall not proceed with additional scope of work without a signed approval by the Owner.

C. Additional work performed by the Contractor will not be paid by Owner without signed approval of these changes prior to implementing changes. Submit a copy of signed change order upon billing.

1.11 USE OF THE SITE

A. Use of the site shall be at the Owner's direction in matters in which the owner deems it necessary to place restriction.

B. Access to building wherein the Work is performed shall be as directed by the Owner.

C. The Owner will occupy the premises during the entire period of construction for conducting his or her normal business operations. Cooperate with the owner to minimize conflict and to facilitate the owner's operations.

D. Schedule necessary shutdowns of plant services with the Owner, and obtain written permission from the owner. Refer to article - CONTINUITY OF SERVICES herein.

E. Proceed with the Work without interfering with ordinary use of streets, aisles, passages, exits, and operations of the owner.

F. All Contractor personnel must check in with the facilities engineering department and/or the General Contractor upon arrival and upon departure.

1.12 DELIVERY AND STORAGE

A. Insofar as possible, deliver items in manufacturers' original unopened packaging. Where this is not practical, cover items with protective materials, to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.

B. Store items in a clean dry place and protect from damage.

C. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

D. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

E. Provide protective covering during construction to prevent damage or entrance of foreign matter.

F. Contractor is responsible for on-site security of tools, test equipment and materials.

G. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.13 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 1 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 1 of the Project Manual, or a minimum of four (5) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. Test reports on all copper and optical fiber cables (electronic file format and hard copy).
   3. As-built cable schedules with recorded cable routing and lengths of each designated run.
   4. As built documentation of all cabling systems.
   5. As built documentation of IDF/TR modifications and associated cabinet elevations.

B. Warranty, Operation, and Maintenance:
   1. Test Report Binder(s)
      a. Commercial quality black, 3-ring binders with clear, durable, cleanable plastic covers.
      b. Minimum size: 1”
      c. Maximum size: 3”
      d. When multiple binders are used, correlate the data into related groupings.
      e. Label contents on spine and face of binder with full size insert label under plastic cover.
   2. Form of Operation/Maintenance Manuals
      a. Prepare data in form of an instructional manual for use by Owner’s personnel.
      b. Format:
         1) Size: 8 ½” x 11”.
         2) Text: Manufacturer’s printed data or neatly typewritten
      c. Drawings:
         1) Provide reinforced punched binder tab and bind in text.
         2) Fold larger drawings to size of text pages
      d. Provide flyleaf indeed tabs for each separate product or each piece of operating equipment.
      e. Cover: Identify each volume with typed or printed title “Operating and Maintenance Instructions.” List:
         1) Title of Project
         2) Identity of separate structures as applicable.
         3) Identity of general subject matter covered in the manual.
   3. Content of Operations/Maintenance Manuals
      a. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
         1) Contractor, name of responsible principal, address and telephone number.
         2) A list of each product required to be included, indexed to content of the volume.
         3) List with each product, name, address and telephone number of:
            a) Subcontractor or installer. •
            b) Maintenance contractor as appropriate.
            c) Identify area of responsibility of each.
            d) Local source of supply for parts and replacement.
         4) Identify each product by product name and other identifying symbols as set forth in Contract Documents.
      b. Product Data:
         1) Include those sheets pertinent to the specific product.
         2) Annotate each sheet to:
            a) Identify specific product or part installed.
            b) Identify data applicable to installation.
            c) Delete references to inapplicable information.
      c. Drawings:
         1) Supplement product data with drawings as necessary to illustrate:
            a) Relations of component parts of equipment and systems.
            b) Cable Plant Layout
         2) Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
         3) Do not use Project Record Documents as maintenance drawings.
      d. Written text as required to supplement product data for the installation:
         1) Organize in consistent format under separate headings for different procedures.
         2) Provide logical sequence of instructions for each procedure.
      e. Copy of each warranty, bond and service contract issued.
         1) Provide information sheet for Owner's personnel, giving:

a) Proper procedures in event of failure.
b) Instances which might affect validity of warranties or bonds.

f. Shop drawings, coordination drawings and product data as specified.

C. Sections for Equipment and Systems.
1. Content for each unit of equipment and system as appropriate:
a. Description of unit and component parts.
1) Function, normal operating characteristics, and limiting conditions.
2) Performance data, engineering data and tests.
3) Complete nomenclature and commercial number of replaceable parts.
b. Operating procedures:
1) Start up, routine and normal operating instructions.
2) Regulation, control, stopping, shut down and emergency instructions.
3) Special operating instructions.
c. Maintenance procedures:
1) Routine operations
2) Guide to trouble-shooting.
3) Disassembly, repair and reassembly.
4) Adjusting and checking.
5) Routine service
d. Manufacturer's printed operating and maintenance instructions.
e. Copies of typed directories of station outlets to reflect aerial room graphics numbers and room names (not architectural room numbers from the drawings).
1) Data and Voice Distribution
2) Security Devices
f. Original manufacturer's paths list, illustrations, assembly drawings and diagrams required for maintenance.
1) Items recommended to be stocked as spare parts.
g. Schedule of low voltage wire and cable
h. Schedule of Communications station outlets and wiring devices
i. Schedule of security field devices
j. Each Contractor's coordination drawings.
1) As installed color coded wiring and cabling diagrams.
k. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.
l. Other data as required under pertinent sections of the specifications.
2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications.
4. Provide complete information for products specified in Division 27.
5. Provide certificates of compliance as specified in each related section.
6. Provide staid up and testing reports as specified in each related section.
7. Provide signed receipts for spare parts and material.
8. Provide training report and certificates.

1.14 RECORD DRAWINGS

A. Keep a hard copy set of project drawings at the job site exclusively for recording deviations from the Construction Drawings.

B. Record locations and depths of buried and concealed conduits from fixed, easily identifiable objects, such as building walls. Where conduits are concealed in walls, indicate distances off of building corners or other building features not likely to be disturbed by future alterations.

C. Mark deviations in a different color so that work of various systems can be easily identified.

D. When Work is completed, record all deviations in an electronic format using AutoCAD 2010 in a format usable to the Owner. Coordinate this format with the Owner.

E. Submit two copies of completed "record drawings" on electronic media such as CD or DVD to Owner's Representative for distribution.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All materials and equipment used in carrying out these specifications are to be new and have UL listing, or listing by other recognized testing laboratory when such listings are available.

B. Model numbers and manufacturers included in this specification are listed to establish as standard of product quality.

C. Other qualified manufacturers may be substituted only with The Owner's written consent. To request a substitution, the Contractor shall submit complete technical data, samples, and if requested, results of independent testing laboratory tests of proposed equipment.
   1. If proposed System includes equipment other than specified model numbers, submit a list of major items and their quantities, with a one-line schematic diagram for review.
   2. Material not specifically identified within this document but which is required for the successful implementation of the intended system(s), shall be of the same class and quality as the specified material and equipment.
   3. Include a list of previously installed projects using proposed equipment that are similar in nature to specified system.

PART 3 - EXECUTION

3.1 COORDINATION

A. Insofar as it is possible to determine in advance, advise the General Contractor to leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should the Contractor neglect doing this, any cutting and/or patching required is to be done at this Contractor's expense. Visit site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work involved.

B. Carefully coordinate with other divisions to ensure proper power requirements, grounding, fireproofing and interlocking controls between the fire alarm system, security system, and other owner furnished systems.

C. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interferences between work of various Contractors to be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to Owner.

D. The Owner or the Owner's Representative shall be the mediating authority in all deviation and disputes arising on project.

E. Coordinate with local telephone and cable service providers to assure that proper points of service, demarcation location and grounding requirements are in accordance with contract drawings. Duct bank is to be provided by Division 26. This Contractor shall be involved regarding discussions about services to the building.
   1. Coordinate with other trades to provide wall and ceiling access panels wherever required for access to communication equipment.

F. Intent:
   1. These sections of specifications and drawings form a complete set of documents for communications systems for this project. Neither is complete without the other. Any item mentioned in one shall be as binding as though mentioned in both.
   2. The intent of these specifications and drawings is to form a guide for a complete systems installation. Where an item is reasonably necessary for a complete system but not specifically mentioned, such as pull boxes, fittings, expansion fittings, support hangers, etc. provide same without additional cost to Owner.
   3. Communication equipment room layouts indicted on drawings are diagrammatical only. Exact location of outlets and equipment to be coordinated and governed by project conditions. The designer reserves the right to make any reasonable changes (approximately 6 feet) in location of junction boxes, or equipment prior to roughing in of such without additional cost to Owner.

G. Deviations:

1. No deviations from specifications and drawings to be made without full knowledge and consent of the designer.
2. Should the Contractor find during progress of work that existing conditions make desirable a modification of the requirements of any particular item, report such item promptly to the designer for his decision and instructions.

H. Main Horizontal Pathway/Raceway
1. Unless otherwise noted on the drawings, all communications/low voltage systems cabling shall be routed above accessible corridor ceilings parallel to room walls and corridors via cable tray or J-hook supports. Cabling shall be segregated by function as follows:
2. Voice/data cabling.
3. All other systems.

3.2 CONTINUITY OF SERVICES

A. The Contractor shall not take any action that will interfere with, or interrupt, existing building services unless previous arrangements have been made with the owner's representative. Arrange the Work to minimize shutdown time.

B. Owner's personnel will perform shutdown of operating systems. The Contractor shall give three (3) days' advance notice for systems shutdown.

C. Should services be inadvertently interrupted, immediately furnish labor, including overtime, material, and equipment necessary for prompt restoration of interrupted service.

3.3 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Trenching, Excavation, and Backfilling is the responsibility of the General Contractor. This Contractor is to coordinate all requirements with the GC. Failure to properly coordinate this effort resulting in additional trenching, excavation, backfilling, or repairs shall be performed without additional cost to Owner.

3.4 PLYWOOD BACKBOARD AND WALL BACKING

A. Contractor shall provide 4' W x 8' H x 3/4" D fire retardant plywood backboard on each wall in all Communication Rooms where shown on drawings. Plywood is to be painted with two coats of flat white fire retardant paint on all six sides and installed 6" above finished floor. The fire rating on the plywood shall be masked prior to painting and the mask removed after installation such that the fire rating is always visible.

B. General Contractor is to provide appropriate backing in walls as required for mounting brackets and other wall mounted equipment per manufacturer requirements.

C. Where work is to be done in an existing Telecommunication Room (TR), the Contractor shall ensure plywood in the TR is flame retardant. If the existing plywood does not comply the Contractor shall replace it with plywood compliant with 3.4.A.

3.5 FIRESTOPPING

A. Select appropriate type or types of through penetration firestop devices or systems appropriate for each type of communications penetration and base each selection on criteria specified herein.

B. Selected systems shall not be less than the hourly time delay ratings indicated in the Contract Documents for each respective fire-rated floor, wall, or other partition of building construction. Firestop for each type of communications penetration shall conform to requirements of an independent testing laboratory design drawing or manufacturer's approved modification when used in conjunction with details shown on the Drawings.

C. Perform all necessary coordination with trades constructing floors, walls, or other partitions of building construction with respect to size and shape of each opening to be constructed and device or system approved for use in each instance.

D. Coordinate each firestop selection with adjacent Work for dimensional or other interference and for feasibility. In areas accessible to public and other "finished" areas, firestop systems Work shall be selected, installed, and finished to the quality of adjacent surfaces of building construction being penetrated.

E. Use materials that have no irritating or objectionable odors when firestopping is required in existing buildings and areas that are occupied.

F. Provide damming materials, plates, wires, restricting collars, and devices necessary for proper installation of Firestopping. Remove combustible installation aids after firestopping material has cured.

G. All firestops shall be installed in accordance with the manufacturer’s instructions in order to maintain the specific rating assigned by the independent testing laboratory.

H. Existing raceways, cable trays, and cabling that penetrate existing building construction shall be firestopped to the extent necessary to fill cavities that may exist between existing building construction and existing communications penetrations or existing conduit sleeve, and between existing conduits and existing conduit sleeve.

I. If required by inspecting authorities:
   1. Expose and remove Firestopping to the extent directed by inspecting authority to permit his or her inspection.
   2. Reinstall new firestopping and restore Work where removed for inspection.

3.6 TESTS

A. On completion of Work, installation shall be entirely free of damaged conductors, software errors, incomplete jack termination including labeling and faceplates and dust. Perform a thorough operation test in the presence of the Owner or their representative. Provide documentation of all test results as outlined in each system’s specifications. Include labor, materials and instruments for above tests.

B. Furnish owner, as a part of closing documents, a copy of such tests including identification of each cable, also the dedicated communication service ground test as required by each systems individual manufacturer indicating compliance with their requirements.

C. Prior to final observation and acceptance, test and leave in satisfactory operating condition, all systems and equipment including but not limited to the following:
   1. Grounding.
   2. Firestopping of all sleeves and conduits.
   3. Telephone and LAN systems.
   4. Turn in test results on cabling.

3.7 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, dust, and construction debris and repair damaged finish, including chips, scratches, and abrasions. This includes touching up paint removed for grounding.

B. Contractor shall provide a clean work environment, free from trash/rubbish accumulated during and after cabling installation.

C. Maintain construction materials and refuse within the area of work. Clean the work area at the end of each day.

D. Contractor shall keep all drinks (coffee, sodas, etc.) off finished floors, carpets, tiles, racks and equipment. If any liquid damage to above finishes or equipment, Contractor shall provide professional services to clean or repair scratched/soiled finishes or damaged equipment at own expense.

3.8 INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for communication systems installation. Work shall not start until all permit applications are approved.

3.9 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to substantial completion, conduct an on-site training program to instruct Owner's operating personnel in the operation and maintenance of the communications systems.
   1. Provide the training during regular working day.
   2. The Ins0vctors shall be experienced in their phase of operation and maintenance of the electrical systems and with the project.

B. Time to be allocated for instructions.
   1. Minimum of 12 hours dedicated instructor time
   2. 4 hours on each of 3 days
   3. Additional instruction time for specific systems as specified in other Sections.

C. Before on-site training, submit the program syllabus; proposed time and dates; for review and approval, minimum 48 hours prior to proposed training time and date.
   1. One copy to the Owner
   2. One copy to the Architect/Engineer

D. The Owner shall provide a list of personnel to receive instructions, and shall coordinate their attendance at file agreed upon times.

E. Use operation and maintenance manuals as the basis of instruction. Review manual with personnel in detail. Explain all aspects of operation and maintenance.

F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.

G. Demonstrate equipment functions (both individually and as part of the total integrated system).

H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.

I. Submit a report within one week after completion of training. List time and date of each demonstration, hours devoted to the demonstration, and a list of people present, with their respective signatures.

J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he/she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.

K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operating and Maintenance Manual.

3.10 OBSERVATIONS

A. When field observation services are a part of the project scope, the designer's office will provide periodic observation of the progress of Work specified herein. The purpose of the observation service is to ensure compliance of Contractor's Work with specifications and drawings. The designer's office may also observe tests required of this Contractor as called for in other sections of the specifications.

B. Specifications and drawings represent Work to be done in view of total project requirements. To eliminate possible conflict with other trades, final location of conduits, jacks, outlets, components, etc., is responsibility of this Contractor. Contractor to provide all supervision required for his personnel to ensure that installation is made in accordance with specifications and drawings and all safety rules and regulations are observed. In event of conflicts of Work on project with other trades, Contractor is to make every reasonable effort to resolve conflict through meetings and discussions with other parties involved, by preparation of drawings, or other appropriate action. Only after this has been done shall the designer's assistance be requested through the RFI process.

C. When the designer is requested to visit the project to aid in resolution of conflicts, or for witnessing tests, they shall be given a minimum of 48 hours' notice prior to time their presence is requested at job site.

3.11 WARRANTY-GUARANTEE

A. The designer reserves right to accept or reject any part of the installation which does not successfully meet requirements as set out in these specifications.

B. This Contractor shall, and hereby does, guarantee all Work installed under this division shall be free from defects in workmanship and materials for a period of two years from date of final acceptance. This Contractor further agrees to repair or replace any defective material or workmanship which is or becomes defective within the terms of this warranty-guarantee.

C. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

END OF SECTION

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SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes the minimum requirements for the installation of telecommunications grounding systems in Telecommunications Rooms.

C. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Telecommunications Grounding Busbars
   2. Ground Blocks
   3. Compression Lugs
   4. Shield Bond Connectors

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:

1.	ANSI	American National Standards Institute
2.	AWG	American Wire Gauge
3.	BICSI	Building Industry Consulting Service International
4.	EIA	Electronics Industries Association
5.	NECA	National Electrical Contractors Association
6.	NEMA	National Electric Manufacturers Association
7.	NFPA	National Fire Protection Association
8.	RCDD	Registered Communications Distribution Designer
9.	RFP	Request for Proposal
10.	STD	Standard
11.	TGB	Telecommunications Grounding Busbar
12.	TIA	Telecommunications Industry Association
13.	TMGB	Telecommunications Main Ground Bus Bar
14.	UL	Underwriters Laboratories

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the Owner.

C. Strictly adhere to all BICSI, EIA and TIA recommended installation practices when installing telecommunications grounding systems.

D. Contractor’s Qualifications:
   1. Firms regularly engaged in the installation of Electrical Systems or Data Communications cabling and that have five (5) years of installation experience with systems similar to that required for this project.
   2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked and the clients will be asked questions relative to the performance of your company.
   3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.

4. Provide a BICSI RCDD certified professional, or a master electrician, for oversight on this project. This person does not have to be working on-site but must be accessible to answer questions and provide weekly status reports. The RCDD or master electrician shall be a full time employee of the contractor.
5. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the Owner.

E. Manufacturer's Qualifications:
1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

F. Material and Work specified herein shall comply with the applicable requirements of:
1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2010
2. ANSI/NECA/BICSI-568 – Standard for Installing Commercial Building Telecommunications Cabling, 2006
3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises, 2009
4. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard, 2009
5. ANSI/TIA-569-E – Commercial Building Standard for Telecommunications Pathways and Spaces, 2004
6. ANSI/TIA-606-C – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 1993-2012
7. ANSI/TIA-607-D –Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, 2019
8. ANSI/TIA-942 – Telecommunications Infrastructure Standard for Data Centers, 2005
9. NFPA 70 – National Electric Code, 2008
10. BICSI – Telecommunications Distribution Methods Manual, 12th Edition, 2009
11. NEMA – VE 1 – Metal Cable Tray Systems, 2009
12. NEMA – VE 2 – Metal Cable Tray Installation Guidelines, 2006
13. Applicable codes and directives of authorities having jurisdiction

G. Work:
1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the Owner in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by Owner, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The Owner must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the Owner in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 270500.

C. Provide all submittal requirements under this section as a single package.

D. Provide product data for the following:
1. Product data consisting of manufacturers specifications for each type of product to be installed, all applicable certifications and elevation/plan documents supporting compliance with stated Specifications.
2. Proposed format of as-built documentation.

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (5) sets.
1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
2. Provide above closeout documentation as an electronic file in PDF format.

B. Warranty and Maintenance:
1. Record Drawings

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer’s recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the Owner.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics, following Contractor Warranty requirements defined in Division 01. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

PART 2 - PRODUCTS

2.1 GENERAL

A. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

2.2 WALL-MOUNT BUSBARS

A. Telecommunications Grounding Busbar (TGB)
   1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
   2. The busbar shall be 4" (100 mm) high and minimum 12" (300 mm) long and shall have multiple attachment points for two-hole grounding lugs.
   3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD-607-A and shall accept at least 12 lugs with 5/8” (15.8 mm) hole centers and 3 lugs with 1” (25.4) mm) hole centers.
   4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 2” (50 mm) standoff from the wall.
   5. The busbar shall be UL Listed as grounding and bonding equipment.
   6. Acceptable Manufacturers:
      a. Chatsworth Products 40153-012
      b. Harger GBI14412TMGB
      c. Panduit GB4B0612TPI-1
      d. Owner Approved Equivalent.

2.3 BONDING CONDUCTORS

A. Telecommunications Bonding Conductors
   1. Telecommunications bonding conductors shall be a minimum 6 AWG in size.
   2. Conductors shall be composed of solid copper wire strands, surrounded with a green insulating jacket, carrying a THHN rating.
   3. Acceptable products:
      a. Harger 619G
      b. Southwire 204974
      c. Approved equivalent

2.4 BONDING ACCESSORIES

A. Lay-In Ground Terminal Block

1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
2. Ground terminal block shall accept conductors ranging from #14 AWG through 1/0.
3. The conductors shall be held in place by two stainless steel set screws.
4. Ground terminal block shall have two 1/4” (6.4 mm) holes spaced on 5/8” (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
5. Ground terminal block shall be UL Listed as a wire connector.
6. Acceptable Manufacturers:
   a. Chatsworth Products 40167-001
   b. Harger LI2/0142
   c. Owner Approved Equivalent

B. Compression Lugs
1. Compression lugs shall be manufactured from electroplated tinned copper.
2. Compression lugs shall have two holes spaced on 5/8” (15.8 mm) or 1” (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
4. Compression lugs shall be UL Listed as wire connectors.
5. Acceptable Manufacturers:
   a. Panduit LCC Series
   b. Harger
   c. Chatsworth Products
   d. Owner Approved Equivalent

C. Shield Bond Connectors
1. Cable shields of multi-pair communications cables shall be bonded to ground when entering the building using shield bonding connectors with screw stud connection.
2. Shield bond connectors shall be compatible for all cables up to 0.8" (20.3 mm) O.D.
3. Acceptable Manufacturers:
   a. 3M Scotchlok 4460-D
   b. Owner Approved Equivalent

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mount Busbars
1. Attach busbars to the wall with appropriate hardware according to the manufacturer’s installation instructions.
2. Conductor connections to the TMGB or TGB shall be made with 2-Hole Bolt-On Compression Lugs sized to fit the busbar and the conductors.
3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
4. The wall-mount busbar shall be bonded to the main building ground, in the nearest electrical room, as part of the overall Telecommunications Bonding and Grounding System.

B. Ground Terminal Block
1. Every rack and cabinet shall be bonded to the TMGB or TGB.
2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount 2-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

C. Grounding Voice and Data Systems
1. Provide an approved ground at all newly installed distribution frames and protector locations using proper bonding to any existing facility. Ensure ground continuity by properly bonding to any existing facility. Ensure ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework. All grounds shall consist of minimum #6 AWG copper wire and shall be supplied from the Telecommunications Main grounding Busbar or a Telecommunications Grounding Busbar.
2. Bond metallic conduits at one end to proper ground.
3. Provide maximum 0.5 Ohm resistance at 0.05 volts at each ground bar.
4. Ground electronic components, equipment cabinets and racks, cable trays and cable racks.

5. Provide ground lead for copper cable in multiples of 25 or more.
6. For overall-shielded cable, bond shield to proper grounding sources at one end. Do not loop ground leads or share with conduit ground leads.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes the minimum requirements for the installation of communications cable pathways outside of Telecommunications Rooms.

C. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Non-Continuous Cable Support Systems
   2. Fire-Rated Pathway Devices
   3. Multi-Service Poke-Through Devices
   4. Conduit Systems
   5. Junction Boxes/ Pull Boxes

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:
   1. AFF Above Finished Floor
   2. ANSI American National Standards Institute
   3. ASTM American Society for Testing and Materials International
   4. BICSI Building Industry Consulting Service International
   5. BOCA Building Officials and Code Administrators International,
   6. CAN Canada/Canadian
   7. EIA Electronics Industries Alliance
   8. EMT Electrical Metallic Tubing
   9. HVAC Heating, Ventilating and Air Conditioning
   10. NEC National Electric Code
   11. NECA National Electrical Contractors Association
   12. NEMA National Electric Manufacturers Association
   13. NFPA National Fire Protection Association
   14. OAR Owner’s Authorized Representative
   15. OD Outer Diameter
   16. RCDD Registered Communications Distribution Designer
   17. RFP Request for Proposal
   18. RMC Rigid Metallic Conduit
   19. STD Standard
   20. TIA Telecommunications Industry Association
   21. UL Underwriters Laboratories
   22. ULC Underwriters Laboratories of Canada

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the OAR.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the OAR.

C. Strictly adhere to all BICSI, EIA and TIA recommended installation practices when installing cable pathways.

D. Contractor's Qualifications:
   1. Firms regularly engaged in the installation of Electrical Systems or Data Communications cabling and that have five (5) years of installation experience with systems similar to that required for this project.
   2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked and the clients will be asked questions relative to the performance of your company.
   3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.
   4. Provide a BICSI RCDD certified professional, or a master electrician, for oversight on this project. This person does not have to be working on-site, but must be accessible to answer questions and provide weekly status reports. The RCDD or master electrician shall be a full-time employee of the contractor.
   5. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the OAR.

E. Manufacturer's Qualifications:
   1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

F. Material and Work specified herein shall comply with the applicable requirements of:
   1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2010
   2. ANSI/NECA/BICSI-568 – Standard for Installing Commercial Building Telecommunications Cabling, 2006
   3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises, 2009
   4. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard, 2009
   5. ANSI/TIA-569-E – Commercial Building Standard for Telecommunications Pathways and Spaces, 2009
   6. ANSI/TIA-606-C – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012
   7. ANSI/TIA-607-D – Generic Telecommunications Grounding (Earthing) and Bonding Requirements for Customer Premises, 2019
   8. ANSI/TIA-942 – Telecommunications Infrastructure Standard for Data Centers, 2006
   9. NFPA 70 – National Electric Code, 2014
   10. BICSI – Telecommunications Distribution Methods Manual, 13th Edition
   11. NEMA – VE 1 – Metal Cable Tray Systems, 2009
   12. NEMA – VE 2 – Metal Cable Tray Installation Guidelines, 2006
   13. Applicable codes and directives of authorities having jurisdiction

G. Work:
   1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
   2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
   3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
   4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the OAR in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The OAR must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the OAR in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Produce Shop Drawings for ALL horizontal and vertical pathways, to include but not limited to, dimensions/size of pathway, routing placement and its location relative to building structure (columns, floor or ceiling) and its relationship to electrical, mechanical elements as well as vertical and horizontal offsets and transitions.

D. Provide all submittal requirements under this section as a single package.

E. Provide product data for the following:
   1. Product data consisting of manufacturers specifications for each type of product to be installed, all applicable certifications and elevation/plan documents supporting compliance with stated Specifications.
   2. Proposed format of as-built documentation.

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (5) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. Provide above closeout documentation as an electronic file in PDF format.
   3. As built documentation of all pathway systems to include cable tray, conduits (horizontal and vertical), and non-contiguous support.

B. Warranty and Maintenance:
   1. Record Drawings

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer's recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics, following Contractor Warranty requirements defined in Division 01. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

PART 2 - PRODUCTS

2.1 GENERAL

A. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

2.2 NON-CONTINUOUS CABLE SUPPORT SYSTEMS

A. Non-Continuous Cable Supports (J-Hooks) Will Be Used
   1. Non-continuous cable supports (j-hooks) are only permitted for use in low voltage cabling installation.
   2. Unless otherwise noted on the drawings, all communications/low voltage systems cabling shall be routed above accessible corridor ceilings parallel to room walls and corridors via cable tray, J-Hooks or conduit. Cabling shall be segregated by function as follows:
      a. Voice/data cabling.

B. Provide through-wall fire-rated pathway devices, as required.
   1. Cables penetrating through fire-rated floors or walls shall utilize fire-rated pathway devices capable of providing an F rating equal to the rating of the barrier in which the device is installed.
   2. The device shall be tested for smoke leakage (L rating) and shall not require the use of any optional sealing materials to achieve the published rating.
   3. The device shall utilize a fire and smoke sealing system that automatically adjusts to the addition or removal of cables.
   4. Wiring devices shall be capable of allowing a 0 to 100-percent visual fill of cables.

5. Wire devices shall be of a sufficient size to accommodate the quantity and size of data cables required and shall be suitable for use with new or existing cable installations.
6. The installed device (in normal use) shall require no maintenance and shall accommodate future cable changes without mechanical adjustment and/or removal or replacement of protective materials.
7. Approved Products:
   a. STI EZ-PATH
   b. Hilti CP 653 Speed Sleeve
   c. Legrand FlameStopper
   d. Owner Approved Equivalent

2.3 POKE-THROUGH DEVICES

A. Multi-Service Poke-Through Devices
   1. Provide floor poke-through devices for feeding cables into the furniture systems.
   2. The device shall provide up to a 2” opening and accepts up to 36 UTP cables.
   3. Device shall be UL Listed and UL Fire Classified under UL514A, UL514C and meet ADA Accessibility guidelines.
   4. Coordinate the flange colors and options with the architect.
   5. Where a combination poke through is required refer to Div. 26 specifications.
   6. Acceptable products:
      a. Wiremold/Legrand
         1) RC9AM2TC Poke-Through Device
      b. Owner Approved Equivalent

2.4 CONDUIT SYSTEMS

A. General
   1. Provide conduit for technology systems as required for installation of communications infrastructure. Conduit shall be provided for all spans of cabling not routed in cable tray.
   2. Provide conduit for installation of all horizontal security cabling infrastructure from end to end.
   3. All conduit system components shall be UL rated.
   4. All conduit system components shall comply with the NEC.
   5. All conduit fittings, junction and pull boxes shall provide minimum cable bend radius is accordance with ANSI/TIA-569E.
   6. All conduit fittings shall have plastic bushings on all exposed conduit ends.

B. Rigid Metal Conduit (RMC) and Fittings Before Coating:
   1. RMC shall be UL6 listed and conform to ANSI C80.4 and NEC Article 344.
   2. RMC coating shall comply with WW-C-581d.

C. Electrical Metallic Tubing (EMT):
   1. EMT shall be UL listed and conform to NEC Article 358.
   2. EMT fittings shall be formed steel compression ring type. Die cast fittings are not allowed.
   3. Only manufacturer’s fittings, adapters, and terminators shall be used.
   4. All transition junction and pull boxes, fittings terminators and adapters shall be a metallic material.
   5. Shall be used inside buildings only.

D. Flexible metal conduit is not permitted.

E. Conduit Bodies are not permitted.

F. Non-metallic conduits are not permitted in above ground installations.

G. Conduit Fittings
   1. All above ground fittings shall be of metallic material.
   2. Conversion fittings are required for non-metallic (below ground) to metallic (above ground) transitions.
   3. All fittings shall be compression or threaded.
   4. Fittings shall provide a secure connection for pulling communications cables.
   5. Setscrew fittings are not permitted.

2.5 JUNCTION BOXES / PULL BOXES

A. All pull boxes shall be constructed with a minimum of 14-gauge Galvanized Steel with an ANSI 61 grey polyester powder finish inside and out over Phosphatized surfaces or Galvanizes Steel unless otherwise specified.

B. All pull boxes shall be minimum NEMA Type 1 rated on concourse level indoor spaces. Pull boxes shall be minimum NEMA Type 3R or NEMA 4 rated in outdoor locations. Boxes are to be sized according to the table below unless otherwise specified.

C. All pull boxes shall have flat, removable covers fastened with plated steel screws within unique keyhole screw slots in the cover to permit removal of the cover without extracting screws unless otherwise specified.
   1. All removable box covers shall be connected to box with a safety strap or chain.
   2. Remove all box covers before completing installation. Prepare properly and paint covers per the following color code by discipline; communication – blue, fire – red, security – green. Re-install painted covers to respective pull boxes.

D. All pull boxes shall provide the appropriate provisioning for grounding.

Maximum Trade Size of Conduit (inches)	Minimum Box Size (inches)			For Each Additional Conduit Increase Width (inches)
	Width	Length	Depth	
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

2.6 OUTSIDE PLANT CABLE AND EQUIPMENT

A. All OSP cable shall be in conduit and fabric innerduct for entire length.

B. Handhole
   1. Install a minimum size handhole of 48”w x 48”l x 24”d.
   2. Install a bolt down cover, rated H-20.
   3. Install a minimum of 6” of gravel in the bottom of the handhole.
   4. Install a minimum of two 24” cable racks on each wall and four 7.5” rack hooks for each cable rack.
   5. Install handholes of additional depth as required to ensure minimum conduit depth is maintained throughout.
   6. Install a cover labeled “Telephone” or “Communications” with 2” high case lettering. Label verbiage to be decided by Owner.
   7. Install pre-cast polymer concrete type handhole.

C. Conduit caulking compound
   1. Compounds for sealing conduit ducts shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees Fahrenheit, shall not slump at a temperature of 300 degrees Fahrenheit, and shall not harden materially when exposed to the air. Compounds shall readily caulk or adhere to clean surfaces of plastic conduit, metallic conduit, or conduit coatings; concrete, masonry; any cable sheaths, jackets, covers, or insulation material, and the common metals. Compounds shall form a seal without dissolving, noticeable changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect on the hands of workers or upon materials. Compound shall be STOPAQ 2100 from Corrosion Control Products Company or approved equal.

D. Fabric innerduct
   1. Install a fabric innerduct in each of the underground conduits installed.
   2. The fabric innerduct shall be sized for the conduit that it is installed in and contain (3) cells.
   3. Pull tape shall be included in each of the innerduct cells.
   4. Acceptable products
      a. Maxcell
      b. Owner approved equivalent

PART 3 - EXECUTION

3.1 GENERAL

A. All conduits and junction boxes shall be concealed or in-wall. If this is not obtainable in any given area, the contractor will notify architect/owner before installation.

B. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded per NEC.

C. The routing and location of all conduits, cable tray, cable hooks and other raceways shall be coordinated with other trades prior to and during building construction to avoid delays and conflicts.

D. Conduit shall be provided for all security system infrastructure pathway, unless specifically noted otherwise on the drawings.

E. Where raceways pass through walls, partitions and floors, seal penetrations to provide a neat installation that will maintain the integrity of the waterproofing or fireproofing, as applicable, of the structure. Coordinate installation requirements with roofing installer where conduits pass through the roof.

F. All Raceways shall be run at least 6-inches from hot flues, steam pipes, hot water pipes and other hot surfaces.

G. All raceways entering a building from underground shall be sealed to prevent water, moisture, gas, or other foreign matter from entering the building. Service conduits shall be sealed in accordance with NEC 230-8.

H. Contractor’s on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and records drawings.

I. DO NOT route communication pathways under HVAC condensing units.

J. Expansion Fittings:
   1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
   2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit funs where necessary. Provide bonding jumpers across fittings in metal raceway systems.

3.2 INSTALLATION

A. Non-Continuous Cable Supports (J-Hooks) will Be Used
   1. Non-continuous cable supports (j-hooks) are only permitted for use in low voltage cabling installation.

B. Firestopping
   1. Comply with manufacturer’s product data, including product technical bulletins, product catalog installation instruction, and product carton instruction for installation.
   2. Verify substrate conditions are acceptable for product installation in accordance with manufacturer’s instructions.
   3. Install firestopping to comply with performance requirements specified herein.
      a. Install firestopping to comply with listed fire rated assemblies in accordance with ASTM and UL requirements.
      b. Installer shall be trained and approved by the manufacturer.
   4. Protect installed products from damage during construction operations until final completions.

5. Inspection: Code official or building inspectors to review proper installation using manufacturer's guidelines.

3.3 CONDUIT INSTALLATION

A. Conduit shall be installed with threaded fittings and couplings.

B. All metallic couplings, connectors and fittings shall be malleable Iron or Steel and finished with Zinc plating or by Galvanizing.

C. All conduits shall be plugged immediately upon installation to prevent the entrance of construction dirt and debris. All conduits shall be swabbed and cleaned before wires are pulled:

D. Expansion fittings shall be utilized in all cases where conduits pass through building expansion joints. Fittings shall be of an approved weatherproof telescopic type bonding jumpers around or through the fitting.

E. Connection of Conduit to Pull / Junction Boxes and Enclosures:
   1. Connection to NEMA 1 type boxes and enclosures:
      a. Rigid conduit: Install insulated bushings and double locknuts.
      b. EMT: Install compression box connectors with insulated throats.
   2. Connection to NEMA 3R, 4, 4X, and 12 type boxes: Install insulated bushings and sealing locknuts or hubs.
   3. When conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the giver circuit.
   4. Install sealing bushing within all conduits which have entered a building from outside, whether from above or below grade.

F. Each Conduit route shall be installed with the least amount of bends as possible. No section of conduit shall be longer than 30 meters (100 feet) or contain more than two 90-degree bends (offset is considered to be a 90-degree bend) between pull points, pull boxes or reverse bends.

G. The inside radius of bends in conduit shall be.
   1. 6 times the internal diameter for 2-inches or less.
   2. 10 times the internal diameter for greater than 2-inches.

H. A measured pull tape shall be placed in all installed conduit.

I. Any single conduit run extending from an IDF/MDF shall not serve more than one outlet.

J. All communication conduits shall be identified with color coded blue tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-Box locations) with the origination and destination location.

K. Conduit shall be reamed to eliminate sharp edges and terminated with an insulated bushing.

L. Conduit protruding through the floor shall be terminated at a minimum of 3 inches above the floor surface.

M. All stubbed conduit ends shall be provided with a ground bushing.

N. All conduit penetrations shall be provided with the proper conduit sleeves.
   1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
   2. Sleeves shall be installed in the communications room floor or ceiling a minimum of two to four inches on center from the wall.
   3. Conduit floor sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
   4. Shall be installed in a single tier or row from left to right horizontally. If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.
   5. Cable support anchors shall be installed 18 to 24 inches above the sleeves.

O. All cable (horizontal, riser or backbone) wall or ceiling penetrations shall be provided with the proper conduit sleeves.

1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
2. Sleeves shall be installed in the floor or ceiling a minimum of two to four inches on center from the wall.
3. Sleeves shall be installed in the walls at a minimum of two inches extended on each side of the wall.
4. Cable floor, ceiling and wall sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
5. Shall be installed in a single tier or row from left to right horizontally.
6. If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.
7. Cable support anchors shall be installed 18 to 24 inches above the sleeves.

P. All conduit and cabinet entrances shall be sealed with an approved, re-enter able sealant material to prevent ingress of water, dust or other foreign materials.

Q. Conduit shall not be embedded in the required fire protective covering of a structural member that is to be individually encased in accordance with BOCA.

R. Install all exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.

S. Conduit Sizing and supports:
1. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.
2. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, termination equipment or cable tray, as indicated in Drawings.
3. Each route shall be installed with the least amount of conduit bends. Each single horizontal conduit run shall be provided with a junction or pull box every 30 meters (100 feet) or contain more than two 90-degree bends (offset is considered to be a 90-degree bend).
4. Each dual horizontal conduit run shall be provided with a Junction or Pull Box every 30 meters (100 feet) or contain more than two 90-degree bends (offset is considered to be a 90-degree bend). The quantity of conduits entering the Junction or Pull Box shall equal the number of conduits exiting the Junction or Pull Box.
5. Each terminating (outlet end) conduit connection shall be provided with the proper connecting insulated bushing or fitting.
6. Each originating end (communications room end) shall be provided with the proper connecting insulated ground bushing and properly bonded to ground.

T. Horizontal Conduit Routes:
1. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.
2. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, termination equipment or cable tray, as indicated in Drawings.
3. Each route shall be installed with the least amount of conduit bends. Each single horizontal conduit run shall be provided with a junction or pull box every 30 meters (100 feet) or contain more than two 90-degree bends (offset is considered to be a 90-degree bend).
4. Each dual horizontal conduit run shall be provided with a Junction or Pull Box every 30 meters (100 feet) or contain more than two 90-degree bends (offset is considered to be a 90-degree bend). The quantity of conduits entering the Junction or Pull Box shall equal the number of conduits exiting the Junction or Pull Box.
5. Each terminating (outlet end) conduit connection shall be provided with the proper connecting insulated bushing or fitting.
6. Each originating end (communications room end) shall be provided with the proper connecting insulated ground bushing and properly bonded to ground.

U. Horizontal conduit entrance in communications rooms – wall entry
1. Horizontal conduits shall enter the communications room wall 12 to 18 inches above the top of the cable tray. Maintain cable bend radius with supporting device as required.
2. Conduit wall stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.
3. All conduit wall stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
4. Conduit crossovers are not permitted.

V. Horizontal conduit entrance in communications rooms – ceiling entry
   1. Horizontal conduits shall enter or be extended from the equipment room ceiling 12 to 18 inches above the top of the cable tray.
   2. Ceiling conduit stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.
   3. All ceiling conduit stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
   4. Conduit crossovers are not permitted.

W. Horizontal conduit entrance in communications rooms – floor entry
   1. Horizontal conduits shall enter the communications room floor 2 to 4 inches on center from the wall and shall be stubbed 3 inches AFF.
   2. Conduit floor stubs shall be spaced in increments equal to the conduit OD from each other.
   3. Conduit crossovers are not permitted.
   4. Provide vertical ladder rack or d-hooks properly secured to wall to transverse cable to cable tray overhead.

X. Horizontal conduit to cable tray
   1. Non-communications conduit shall NOT be attached to the cable tray in any fashion.
   2. Conduit terminating end shall be attached to cable tray side rail with “conduit-to-cable tray” clamps. No other form of attachment shall be permitted.
   3. Top or bottom cable tray conduit feeds and attachments are not permitted.

Y. Horizontal Junction/Outlet Boxes
   1. Each horizontal conduit shall be terminated into an outlet box.
   2. Each outlet box shall be a deep 4-inch square junction box with a minimum of two 1-inch knockouts on each of the sides.
   3. Each conduit home run shall be provided with a deep 4-inch square junction box (w/cover) at 100-foot intervals and 6 inches above each ceiling and wall intersection.

Z. Riser conduit entrance in communications rooms – wall entry
   1. Riser conduits shall enter the communications room wall a minimum of 24 inches above the top of the cable tray.
   2. Conduit wall stubs shall be spaced in increments to equal the conduit OD from each other.
   3. Riser conduits shall be installed in a single tier or row from left to right horizontally.
      a. If two tiers or rows are required, the conduits shall be staggered between tiers.
      b. No more than two tiers or rows are permitted.
   4. All conduit wall stubs shall be extended to and over the cable tray to access cable tray pathway.
   5. All rise conduit stubs shall be provided with the proper universal drop-out/waterfall cable exit runway, which shall be supported by and mounted to channel strut.
   6. Conduit crossovers are not permitted.

3.4 TESTING

A. Test cable trays to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.

B. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1; including test reports verifying rung load capacity in accordance with NEMA VE-1 Section 5.4.

END OF SECTION

SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes the minimum requirements for the labeling of communications infrastructure.

C. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Equipment Rack Labels
   2. Copper Tie Block Labels
   3. Patch Panel Labels
   4. Cable Labels
   5. Faceplate Labels
   6. Conduit System Labels
   7. Ground Tags
   8. Innerduct Tags

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:
   1. ANSI American National Standards Institute
   2. AWG American Wire Gauge
   3. BICSI Building Industry Consulting Service International
   4. EIA Electronics Industries Association
   5. NECA National Electrical Contractors Association
   6. NEMA National Electric Manufacturers Association
   7. NFPA National Fire Protection Association
   8. OAR Owner’s Authorized Representative
   9. RCDD Registered Communications Distribution Designer
   10. RFP Request for Proposal
   11. STD Standard
   12. TGB Telecommunications Grounding Busbar
   13. TIA Telecommunications Industry Association
   14. TMGB Telecommunications Main Ground Bus Bar
   15. UL Underwriters Laboratories

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the OAR.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the OAR.

C. Strictly adhere to all BICSI, EIA and TIA recommended installation practices when installing communications labeling systems.

D. Contractor’s Qualifications:
   1. Firms regularly engaged in the installation of Communications Cabling or Electrical Systems and that have five (5) years of installation experience with systems similar to that required for this project.

2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked, and the clients will be asked questions relative to the performance of your company.
3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.
4. Provide a BICSI RCDD certified professional, or a master electrician, for oversight on this project. This person does not have to be working on-site but must be accessible to answer questions and provide weekly status reports. The RCDD or master electrician shall be a full-time employee of the contractor.
5. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the OAR.

E. Manufacturer's Qualifications:
1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

F. Material and Work specified herein shall comply with the applicable requirements of:
1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2010
2. ANSI/TIA606-C– Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012
3. NFPA 70 – National Electric Code, 2017
4. BICSI – Telecommunications Distribution Methods Manual, 13th Edition
5. Applicable codes and directives of authorities having jurisdiction

G. Work:
1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the OAR in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The OAR must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the OAR in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Provide product data for the following:
   1. Product data consisting of manufacturers specifications for each type of product to be installed, all applicable certifications and elevation/plan documents supporting compliance with stated Specifications.
   2. Proposed format of as-built documentation.

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (5) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. Provide above closeout documentation as an electronic file in PDF format.

B. Warranty and Maintenance:
   1. Record Drawings

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer's recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics, following Contractor Warranty requirements defined in Division 01. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

PART 2 – PRODUCTS

2.1 GENERAL

A. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

B. Labels and markings shall be physically and chemically resistant to damage that would render the label unreadable.

C. All labels shall be TIA/EIA-606-C compliant labeling products. All cables, faceplates, patch panels, copper riser termination blocks, conduit, innerduct and patch cords shall be labeled to TIA/EIA-606-C standards.

2.2 ADHESIVE COMPONENT LABELS

A. Outlet Label - 2-Port Identifier
   1. Ink/laser printed labels shall be constructed of die-cut, adhesive polyolefin.
   2. Thermal transfer labels shall be constructed of die-cut, adhesive polyester.
   3. Label shall be 1.25" (31.8 mm) W x 0.30" (7.6 mm) H.
   4. The label shall be white in color, with black machine-printed characters.
   5. Acceptable products:
      a. Panduit
         1) C125X030FJC Network Label, P1 Cassette
         2) C125X030FJJ Network Label, Laser/Ink Jet
         3) C125X030YPT Network Label, Thermal Transfer
      b. Brady
      c. HellermannTyton
      d. Owner approved equal

B. Copper Patch Panel and Work Area Outlet Label, 4-Port
   1. Ink/laser printed labels shall be constructed of die-cut, adhesive polyolefin.
   2. Thermal transfer labels shall be constructed of die-cut, adhesive polyester.
   3. Label shall be 2.52" (64.0 mm) W x 0.30" (7.6 mm) H.
   4. The label shall be white in color, with black machine-printed characters.
   5. Acceptable products:
      a. Panduit
         1) C252X030FJC Component Label, P1 Cassette
         2) C252X030FJJ Component Label, Laser/Ink Jet
         3) C252X030YPT Component Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

C. Copper Patch Panel Label, 6-Port
1. Ink/laser printed labels shall be constructed of die-cut, adhesive polyolefin.
2. Thermal transfer labels shall be constructed of die-cut, adhesive polyester.
3. Label shall be 3.79" (96.3 mm) W x 0.30" (7.6 mm) H.
4. The label shall be white in color, with black machine-printed characters.
5. Acceptable products:

a. Panduit

1) C379X030FJC Component Label, P1 Cassette
2) C379X030FJJ Component Label, Laser/Ink Jet
3) C379X030YPT Component Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

D. Fiber Patch Panel Port Labels
1. Ink/laser printed labels shall be constructed of die-cut, adhesive polyester, or black-on-white vinyl tape.
2. Label shall be 3.50" (88.9 mm) W x 1.00" (25.4 mm) H.
3. The label shall be white in color, with black machine-printed characters.
4. Acceptable products:

a. Panduit

1) T100X100VPC-BK Component Label, P1 Cassette
2) C350X100YJJ Component Label, Laser/Ink Jet
3) C350X100YJT Component Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

E. Rack and Cabinet Labels, and Cabinet Row End Labels
1. Ink/laser printed labels shall be constructed of die-cut, adhesive polyolefin.
2. Thermal transfer labels shall be constructed of die-cut, adhesive polyester.
3. Label shall be 2.00" (50.8 mm) W x 1.00" (25.4 mm) H.
4. The label shall be white in color, with black machine-printed characters.
5. Acceptable products:

a. Panduit

1) C200X100YPC Component Label, P1 Cassette
2) C200X100YJJ Component Label, Laser/Ink Jet
3) C200X100YJT Component Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

F. Cabinet Row End Labels
1. Labels shall be constructed of die-cut, adhesive polyester.
2. Label shall be 4.00" (101.6 mm) W x 4.00" (101.6 mm) H.
3. The label shall be white in color, with black machine-printed characters.
4. Acceptable products:

a. Panduit

1) C400X400YJJ Component Label, Laser/Ink Jet

2) C400X400YJT Component Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

G. Raised Panel Rack and Cabinet Labels
1. Label to have a raised thermal transfer printable surface, with high-tack adhesive.
2. Label shall be 2.00" (50.8 mm) W x 1.00" (25.4 mm) H.
3. The label shall be white in color, with black machine-printed characters.
4. Acceptable products:

a. Panduit

1) C200X100APT Component Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

H. Raised Cabinet Row End Labels
1. Label to have a raised thermal transfer printable surface, with high-tack adhesive.
2. Label shall be 3.00" (76.2 mm) W x 2.50" (63.5 mm) H.
3. The label shall be white in color, with black machine-printed characters.
4. Acceptable products:

a. Panduit

1) C300X250APT Component Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

2.3 ADHESIVE WIRE MARKER LABELS

A. Category 6A UTP Cable and Patch Cord Labels
1. Label shall be constructed of self-laminating vinyl.
2. Label shall be 1.50" (38.1 mm) L x 1.00" (25.4 mm) W.
3. Label shall accommodate an outside diameter of 0.16" (4.0 mm) to 0.32" (8.1 mm).
4. The print-on area height shall be 0.50" (12.7 mm) and shall be white in color, with black machine-printed characters.
5. Acceptable products:

a. Panduit

1) S100X150VAC Self-Laminating Label, P1 Cassette
2) S100X150YAJ Self-Laminating Label, Laser/Ink Jet
3) S100X150VAT Self-Laminating Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

B. Fiber (2 mm & 3 mm) Cable Labels
1. Label shall be constructed of self-laminating vinyl.
2. Label shall be 1.60" (40.6 mm) L x 1.00" (25.4 mm) W.
3. Label shall accommodate an outside diameter of 0.25" (6.4 mm).
4. The print-on area height shall be 0.80" (20.3 mm) and shall be white in color, with black machine-printed characters.
5. Acceptable products:

a. Panduit

1) S100X160VAC Self-Laminating Label, P1 Cassette
2) S100X160YAJ Self-Laminating Label, Laser/Ink Jet
3) S100X160VAT Self-Laminating Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

C. Fiber Duplex and Ribbon Cable Labels
1. Label shall be constructed of self-laminating vinyl.
2. Label shall be 2.20" (55.9 mm) L x 1.00" (25.4 mm) W.
3. Label shall accommodate an outside diameter of 0.48" (12.2 mm).
4. The print-on area height shall be 1.10" (27.9 mm) and shall be white in color, with black machine-printed characters.
5. Acceptable products:

a. Panduit

1) S100X220VAC Self-Laminating Label, P1 Cassette
2) S100X220YAJ Self-Laminating Label, Laser/Ink Jet
3) S100X220VAT Self-Laminating Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

D. Copper Riser Cable
1. Label shall be constructed of self-laminating vinyl.
2. Label shall be 2.25" (57.2 mm) L x 1.00" (25.4 mm) W.
3. Label shall accommodate an outside diameter of 0.24" (6.1 mm) to 0.48" (12.2 mm).
4. The print-on area height shall be 0.75" (19.1 mm) and shall be white in color, with black machine-printed characters.
5. Acceptable products:

a. Panduit

1) S100X225VAC Self-Laminating Label, P1 Cassette
2) S100X225YAJ Self-Laminating Label, Laser/Ink Jet
3) S100X225VAT Self-Laminating Label, Thermal Transfer

b. Brady
c. HellermannTyton
d. Owner approved equal

2.4 WIRE MARKER LABEL CORES

A. Fiber Label Core
1. Label identification sleeve for fiber jumpers.
2. Sleeve locates on a straight section of cable of at least 2.00" from fiber boot.
3. Sleeve made of flexible PVC material.
4. Acceptable products:

a. Panduit

1) NWSLC-2Y for 2 mm Simplex Fiber, Yellow
2) NWSLC-3Y for 3 mm Simplex Fiber, Orange
3) NWSLC-7Y for 3 mm Duplex Fiber, White

b. Owner approved equal

2.5 NON-ADHESIVE LABELS

A. Outlet Label, 2-Port
   1. Label shall be constructed of die-cut, non-adhesive polyester.
   2. Label shall be 1.25" (31.8 mm) W x 0.40" (10.2 mm) H.
   3. The label shall be white in color, with black machine-printed characters.
   4. Acceptable products:

      a. Panduit

         1) C195X040Y1C Component Label, P1 Cassette
         2) C195X040Y1J Component Label, Laser/Ink Jet
         3) C195X040Y1T Component Label, Thermal Transfer

      b. Brady
      c. HellermannTyton
      d. Owner approved equal

B. Copper Patch Panel and Work Area Outlet Label, 4-Port
   1. Label shall be constructed of die-cut, non-adhesive polyester.
   2. Label shall be 2.61" (66.3 mm) W x 0.35" (8.9 mm) H.
   3. The label shall be white in color, with black machine-printed characters.
   4. Acceptable products:

      a. Panduit

         1) C261X035Y1C Component Label, P1 Cassette
         2) C261X035Y1J Component Label, Laser/Ink Jet
         3) C261X035Y1T Component Label, Thermal Transfer

      b. Brady
      c. HellermannTyton
      d. Owner approved equal

C. Copper Patch Panel Label, 6-Port
   1. Label shall be constructed of die-cut, non-adhesive polyester.
   2. Label shall be 3.90" (99.1 mm) W x 0.30" (7.6 mm) H.
   3. The label shall be white in color, with black machine-printed characters.
   4. Acceptable products:

      a. Panduit

         1) C390X030Y1C Component Label, P1 Cassette
         2) C390X030Y1J Component Label, Laser/Ink Jet
         3) C390X030Y1T Component Label, Thermal Transfer

      b. Brady
      c. HellermannTyton
      d. Owner approved equal

D. Copper Riser Termination Block Label Insert
   1. Label shall be constructed of die-cut, non-adhesive polyester.
   2. Label shall be 7.50" (190.5 mm) W x 0.50" (12.7 mm) H.
   3. The label shall be white in color, with black machine-printed characters.
   4. Acceptable products:

      a. Panduit

         1) C750X050Y1C Component Label, P1 Cassette
         2) C750X050Y1J Component Label, Laser/Ink Jet
         3) C750X050Y1T Component Label, Thermal Transfer

      b. Brady
      c. HellermannTyton

d. Owner approved equal

PART 3 – EXECUTION

3.1 GENERAL

A. Labeling shall be by mechanical means. Hand-lettered labels are not permitted unless otherwise noted.
   1. Utilize Panduit, or equivalent, labeler and software

B. Tags shall be non-removable.
   1. Exceptions:

      a. Faceplate labels that are placed in recessed label holders
      b. Patch panel labels that are placed in recessed label holders
      c. Telecommunications Ground tags secured with cable ties
      d. Innerduct tags secured with cable ties

C. Labels shall match hardware layout and design.

D. Labels shall be as large as practicable while fitting properly.

E. No lettering shall be smaller than 10-point.

3.2 LABELING STANDARDS

A. Room Identification
   1. Label Communications Backboard or Equipment Rack closest to entry door with unique identifying code.
   2. Characters shall be 1-inch minimum.

B. Equipment Rack Identification
   1. Label each Equipment rack with a unique alpha numeric character indicating a TR/MER and a rack number

      a. Example: TR1-01
   2. Position labels at top of rack.
   3. Characters shall be 1-inch minimum

C. Wall Field Identification
   1. Each wall field chassis must be labeled with the TR/MER ID then an alphabetical code ‘AA’ to ‘ZZ’.
   2. Each wall field row must be labeled numerically starting with ‘01’ at the top.
   3. Each chassis port shall be labeled by Destination Faceplate ID – Chassis# - Row#

      a. Example: TR1-017-AF-04-02

D. Patch Panel and Port Labeling
   1. Patch panel ports are numbered from left to right, top to bottom starting with ’01’ to ‘24’, then for a 48-port patch panel ‘25’- ‘48’.
   2. The top line of the data port label shall indicate the Destination Faceplate

      a. Example: TR1-017
   3. The second line (port label) shall be labeled by Cabinet/Rack# - Rack Unit – Port#

      a. Example: 03-24-15

E. Patch Panel to Patch Panel Labeling
   1. The top line of the label shall indicate Destination Cabinet-Rack ID

      a. Example: TR1-09
   2. The second line of the label shall indicate Destination Rack Unit – Port #

      a. Example: 24-15

F. Telecommunications Outlet Identification
   1. Label each Telecommunications Outlet connector with a unique identifying code

      a. Position labels in recessed label holders on faceplate and cover with plastic covers.

   2. Telecommunications Outlet Faceplate labeling code shall be as follows:

      a. TR/MER – Faceplate number where:

         1) "TR/MER" is identifier for room where cable terminates in horizontal cross-connect.
         2) Faceplate number starts with '001' to '999'
         3) Example: TR1-117

      b. WAO Jack ID

         1) Destination Data room/Cabinet/Rack #-Rack Unit-Port # (e.g. YYY-YY-YY-YY).

            a) Port number starts with '01' to '24' for 24-port patch panel or '48" if connected to a 48-port patch panel.

G. Horizontal Cabling
   1. All horizontal cables shall be labeled at Telecommunications outlet and horizontal cross-connect with self-laminating labels via Panduit labeler and software.
   2. Cables shall be labeled at each end with information indicating termination point of both ends of cable as follows:

      a. TR/MER – Faceplate #, Rack #/Wall Field ID – Rack Unit/Row – Port #

         1) Example:

            a) Data Cable: TR1-017-03-21-03
            b) Voice Cable: TR1-0122-AA-21-03

   3. Cables shall be labeled on a visible part of the cable within three to six (3-6) inches of termination point for ease of identification after termination.
   4. Labels at the telecommunications outlet shall be visible by removing the faceplate.
   5. Rooms with multiple outlet locations shall be numbered sequentially beginning clockwise from the first outlet to the left of the main entrance to the room.

H. Backbone Cabling
   1. All backbone cabling shall be labeled at each end with self-laminating labels via Panduit labeling system.
   2. Cables shall be labeled at each end with information indicating termination point of both ends of the cable as follows:

      a. TR/MER -Cabinet Rack/Wall Field ID – Rack Unit-Row/Destination Cabinet Rack/Wall Field ID-Rack Unit-Row

         1) Example:

            a) Data: TR1-03-06 / MER-02-03
            b) Voice: TR1-AD-02 / MER –AB-03

   3. Cables shall be labeled on a visible part of the cable within twelve (12) inches of termination point for ease of identification after termination.
   4. Fiber backbone cabling shall be labeled at each end with information indicating the building identifier, owner, room, cable number and "FO" indicating fiber.

      a. "S" shall be used after the FO to indicate the use of single-mode fiber.
      b. "M" shall be used after the FO to indicate the use of multi-mode fiber.
      c. Fiber shall be labeled on the front of the fiber enclosure.

         1) SMF for single-mode fiber.
         2) MMF for multi-mode fiber.

I. Outside Plant Cabling (Fiber and Copper)
   1. All outside plant cabling shall be labeled at each end with self-laminating labels via Panduit labeling system.
   2. Cables shall be labeled at each end with information indicating termination point of both ends of the cable as follows:

      a. Field Number –TR/MER –Cabinet/Rack #-Rack Unit / Destination Field number –TR/MER –Cabinet Rack # - Rack Unit
      b. Example: 2349-MER-02-14 / 2476 –RES1-01-16

J. Conduit Labeling
   1. All conduits shall be labeled at each end with self-laminating labels via Panduit labeling system.
   2. Conduits shall be identified in accordance with the identification legend in Appendix A.
   3. Conduits shall be labeled at each end and at each junction box or pull box as follows:

      a. Origin / Destination –Conduit identification

         1) Example: MER / TR1-BR2435
   4. Metallic conduit shall be labeled as follows:

      a. Metallic conduit that is 2” or larger shall be labeled every fifty (50) feet with UV rated, chemical resistant 3” vinyl labels that are ORANGE in color and are affixed with permanent adhesive. Conduit should be marked in 2” black lettering (MAIN lettering) or 1/4” black lettering (SECONDARY lettering).

         1) MAIN lettering shall identify the system.

            a) All conduit shall be marked “COMMUNICATIONS”

         2) SECONDARY lettering shall identify;

            a) Origination
            b) Destination
            c) Construction Contract Number

      b. Metallic conduit that is smaller than 2” shall be labeled with UV rated, chemical resistant 1” vinyl labels that are ORANGE in color and are affixed with permanent adhesive. Conduit should be marked in 3/4” black lettering (MAIN lettering) or 3/16” black lettering (SECONDARY lettering).

         1) MAIN lettering shall identify the system.

            a) All conduit shall be marked “COMMUNICATIONS”

         2) SECONDARY lettering shall identify;

            a) Origination
            b) Destination
            c) Construction Contract Number

K. Fiber Optic Patch Cable Labeling
   1. All backbone cabling shall be labeled at each end with self-laminating labels via Panduit labeling system.
   2. Cables shall be labeled at each end with the origin / destination by TR/ER # - Cabinet/Rack # - Rack Unit # - strand # or switch port

      a. Example: MER-03-40-17/18 /TR1-01-44-17/18

L. Telecommunications Grounds
   1. Label Grounds on a visible part of the ground cable within twelve (12) inches of termination point for ease of identification after termination.
   2. Tags shall be secured to ground cable using self-locking ties

M. Innerduct

1. Innerduct containing fiber optic cable shall be labeled where exposed.

    a. Includes areas where Innerduct is installed in trays and equipment rooms.
2. Label tags to include unique identifiers and pair counts of cable(s) contained therein.

    a. Use Backbone Cable labeling formats as described above.
    b. Hand lettering is acceptable.

        1) Use indelible type ink
3. Tag shall be secured to Innerduct using self-locking ties.

N. Communications Pull Boxes
1. Communications pull boxes shall be have a blue access cover and labeled to indicate that they are reserved for Communications cabling. Label the pull box “COMMUNICATIONS."

END OF SECTION

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 – GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes the minimum requirements for the installation of cabinets, racks, frames and enclosures in data centers, computer rooms and communications equipment rooms.

C. Included in this section are the minimum composition requirements and installation methods for the following:
1. Free standing Equipment Racks
2. Vertical Wire Management
3. Horizontal Wire Management
4. Ladder Rack & Accessories
5. Plywood Backboards

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:
1. AHJ Authority Having Jurisdiction
2. ANSI American National Standards Institute
3. ASTM American Society for Testing and Materials International
4. AWG American Wire Gauge
5. BICSI Building Industry Consulting Service International
6. EIA Electronics Industries Alliance
7. NEC National Electric Code
8. NEMA National Electric Manufacturers Association
9. NFPA National Fire Protection Association
10. OAR Owner’s Authorized Representative
11. RCDD Registered Communications Distribution Designer
12. RFP Request for Proposal
13. RU Rack Unit
14. STD Standard
15. TGB Telecommunications Grounding Busbar
16. TIA Telecommunications Industry Association
17. TMGB Telecommunications Main Ground Bus Bar
18. UL Underwriters Laboratories
19. UPS Uninterruptable Power System

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the OAR.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the OAR.

C. Strictly adhere to all BICSI, EIA and TIA recommended installation practices when installing the products specified in this section.

D. Contractor’s Qualifications:

1. Firms regularly engaged in the installation of Electrical Systems or Data Communications cabling and that have five (5) years of installation experience with systems similar to that required for this project.
2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked and the clients will be asked questions relative to the performance of your company.
3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.
4. Provide a BICSI RCDD certified professional, or a master electrician, for oversight on this project. This person does not have to be working on-site, but must be accessible to answer questions and provide weekly status reports. The RCDD or master electrician shall be a full-time employee of the contractor.
5. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the OAR.

E. Manufacturer's Qualifications:
1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

F. Material and Work specified herein shall comply with the applicable requirements of:
1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2010
2. ANSI/NECA/BICSI-568 – Standard for Installing Commercial Building Telecommunications Cabling, 2006
3. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises, 2009
4. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard, 2009
5. ANSI/TIA-569-E – Commercial Building Standard for Telecommunications Pathways and Spaces, 2004
6. ANSI/TIA-606-C – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012
7. ANS/TIA-607-D – Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002
8. ANSI/TIA-942 – Telecommunications Infrastructure Standard for Data Centers
9. NFPA 70 – National Electric Code, 2017
10. UL 1449 – Standard for Surge Protective Devices.
11. BICSI – Telecommunications Distribution Methods Manual, 13th Edition
12. NEMA – VE 1 – Metal Cable Tray Systems, 2009
13. NEMA – VE 2 – Metal Cable Tray Installation Guidelines, 2006
14. Applicable codes and directives of authorities having jurisdiction

G. Work:
1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the OAR in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The OAR must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the OAR in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Produce Shop Drawings for ALL (tele)communications rooms which shall include dimensions, rack/cabinet placement, cable tray/ladder racking placement, rack/cabinet elevations, and each wall within the space.

D. Provide all submittal requirements under this section as a single package.

E. Provide product data for the following:
   1. Product data consisting of manufacturers specifications for each type of product to be installed, all applicable certifications and elevation/plan documents supporting compliance with stated Specifications.
   2. Proposed format of as-built documentation.

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (5) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. Provide above closeout documentation as an electronic file in PDF format.
   3. Laminated as-built drawing sheet of TR service area representing each level, with a scale of not less than 1/8in, mounted on the wall of each TR.

B. Warranty and Maintenance:
   1. Record drawings of final room configurations

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer's recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics, following Contractor Warranty requirements defined in Division 01. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

PART 2 – PRODUCTS

2.1 GENERAL

A. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

2.2 EQUIPMENT RACKS

A. Free-standing Equipment Racks
   1. Racks shall be manufactured from aluminum extrusion.
   2. Each rack will have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack will assemble with nut and bolt hardware. The base angles will be pre-punched for attachment to the floor.
   3. Equipment mounting channels will be 3" deep and punched on the front and rear flange with the EIA-310-D universal hole pattern to provide 45 rack-mount spaces for equipment. Each mounting space will be marked and numbered on the mounting channel.
   4. When assembled with top and bottom angles, equipment-mounting channels will be spaced to allow attachment of 19" EIA rack-mount equipment. Attachment points will be threaded with 12-24 roll-formed threads. The rack will include assembly and equipment-mounting hardware. Racks will include 50 each combination pan head, pilot point mounting screws.
   5. Two-Post Rack - The assembled rack outside dimensions will be 7' (84") high, 20" wide and 15" deep. The sides (webs) of the equipment-mounting channels will be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying. The rack will be rated for 1,000 lb. of equipment.

6. Four-Post Frame:
   a. Capacity: 2,000 lb. (907.2 kg).
   b. Mounting Channels: Front and rear tapped #12-24 3 inch (76 mm) deep flange with the EIA-310-D Universal hole pattern.
   c. Size: 19 inches (482 mm) wide by 7 feet (2.1 m) high (45U), by 23.2 inches (600mm) deep.
7. The rack will be UL Listed.
8. Finish shall be epoxy-polyester hybrid powder coat in the color black.
9. Acceptable products:
   a. Chatsworth Products, Inc. (CPI)
      1) 2-Post - 55053-703, Standard Rack, 19" x 7', Black, UL Listed.
      2) 4-Post – 50120-703, quadra rack ; 19" w x 7'h x 29" d
      3) 40605-005, Equipment Mounting Screws, #12-24, 50 pack, Black
      4) 40604-003, Rack Installation Kit, Concrete Slab, Zinc
      5) 12816-704, Flush Mount Plug Strip with NEMA L5-15P, and Surge Protection
   b. Owner Approved Equivalent.

B. Standard Wall Mount Cabinets
1. 19" wide rack mount width
2. High-strength, lightweight aluminum construction
3. Standard EIA-310-D hole pattern
4. Swing out design
5. 100lb static load rating
6. Install heavy duty swing gate kit to increase capacity to 150lb
   a. Chatsworth Products, Inc (CPI)
      1) For 18" deep cabinets – 12795-718
      2) For 25" deep cabinets – 12795-725
7. Install vertical cable manager rings every 6"
   a. Chatsworth Products, Inc. (CPI)
      1) Set of 6 Rings, Black - 11799-001
8. Open architecture for airflow and easy cable access
9. Mount on plywood backboard only
10. Support of patch panels, shelves, trays, and network equipment with roll-formed #12-24 tapped mounting holes
    a. Chatsworth Products, Inc. (CPI)
       1) 12U x 25" depth, Standard swing gate wall rack – 11790-725
       2) 20U x 25" depth, Standard swing gate wall rack – 11791-725
       3) 26U x 25" depth, Standard swing gate wall rack – 11807-725
       4) 40U x 25" depth, Standard swing gate wall rack – 11792-725

C. Wall Mount CUBE-IT Cabinet
1. 19" wide rack mount width
2. High-strength, lightweight aluminum construction
3. Standard EIA-310-D hole pattern
4. Three-Part, swing out design
5. Tempered glass door
6. UL 2416 listed, 300 lb load rating
7. Install low -decibel (31dB), dual-fan kit
   a. Chatsworth Products, Inc (CPI)
      1) 40975-001
8. Install horizontal rack mountable power strip
   a. Chatsworth Products, Inc. (CPI)
      1) 12820-701
9. Mount on plywood backboard only
10. Support of patch panels, shelves, trays, and network equipment with roll-formed #12-24 tapped mounting holes
    a. Chatsworth Products, Inc. (CPI)
       1) 24" x 30" depth – 12419-724

D. Vertical Wire Managers
1. Every rack/frame shall have a minimum of one vertical cable manager. The vertical cable manager shall create a space for storing and organizing cables along the side of the rack/frame. The cable manager shall maintain separation between patch/equipment/jumper cords and premise cables.
2. The vertical cable manager shall match the height of the rack(s)/frame(s).
3. The vertical cable manager shall bolt to the side of racks/frames with included hardware.

4. The cable manager shall be sized to match cabling requirements. Maximum cable fill shall be calculated by dividing 50% of the usable area within the cable manager by the area of a single cable.
5. A single vertical cable manager may be used in between bayed racks/frames if it is sized to match cable requirements for both racks/frames.
6. The single-sided vertical cable manager shall be a C-shaped trough with a front door. The single-sided trough shall provide a single cable pathway. The front sides of the cable manager shall have T-shaped cable guides separated by openings that align with each U space on the rack. The back of the manager shall be mostly open to allow easy cable pass-through. Three fixed position accessory mounting panels shall allow attachment of cable management accessories at the back of the manager.
7. The double-sided vertical cable manager shall be a double-sided H-shaped trough with a front door and a rear door. The double-sided trough shall provide independent front and rear cable pathways. The front and rear sides of the cable manager shall have T-shaped cable guides separated by openings that align with each U space on the rack. The middle of the managers shall be mostly open to allow easy cable pass-through. Three movable mid-sections shall allow attachment of cable management accessories inside the cable manager. The movable mid-sections shall adjust front-to-rear to allow a 40/60, 50/50 or 60/40 front/rear split of the interior cable management space.
8. The combination vertical cable manager shall be a single-sided C-shaped trough with a front door and individual cable rings on the rear side. The single-sided trough and cable rings shall provide independent front and rear cable pathways. The front sides of the cable manager shall have T-shaped cable guides separated by openings that align with each U space on the rack. The back of the manager shall have individual rings with plastic spin-open latches. The rings will provide attachment points for cable management accessories inside the cable management trough. Openings between the rings will allow easy cable pass-through.
9. The door shall be removable, hinged to open from the right or left side, with a two-point latch and a single knob on the right and left side to secure the door in the closed position. The front door shall have a two-tone finish: black with a vertical aluminum panel at the center. The rear door on double-sided cable managers shall be flat with a black finish.
10. The T-shaped cable guides shall be made from a composite plastic material (not metal) and shall have rounded edges to protect cables. Openings between the T-shaped guides will be evenly spaced. When the cable manager is attached to a rack/frame, each cable opening shall align with a rack-mount space (U) on the rack/frame. Each opening shall pass a minimum of 24 each .25” OD patch cords.
11. The cable manager shall be delivered individually boxed, and available in several widths as specified below and in the contract documents.
12. The vertical cable manager shall be manufactured from steel, aluminum and plastic.
13. Finish shall be epoxy-polyester hybrid powder coat paint in the color as specified below and in the contract documents. T-shaped cable guides and latch hardware is black.
14. Optional internal cable management accessories will include cable management spools that attach to the panels/mid-sections to provide slack management for patch cords; a cable lashing bar kit to provide tie points for cable bundles at the rear/mid of the manager; and a fiber segregation kit that creates a separate pathway inside the manager to separate fiber from other cables.
15. Acceptable products:
    a. Chatsworth Products, Inc. (CPI), Velocity™ Cable Management:
        1) Part Number 13914-703, Vertical Cable Manager, 7’ High x 10” Wide x 17.5” Deep
        2) Part Number 15008-001, Cable Distribution Spools, Pack of 4, Black.
        3) Part Number 13935-701, Cable Distribution Spools, Pack of 4, Black.
        4) Part Number 13928, Cable Lashing Bar Kit
    b. Owner Approved Equivalent.

E. Horizontal Wire Managers
1. Place horizontal cable managers above and below each patch panel on/in each rack/frame. The horizontal cable manager will guide patch/equipment cords between the vertical cable manager and individual network port connections.
2. The horizontal cable manager shall match the rack-mount width of the rack(s)/frame(s).
3. The horizontal cable manager shall attach to the front or rear of the rack/frame with screws and shall be sized to fit in standard EIA-310-D or EIA-310-E Universal rack-mount spacing (1-3/4in high U).
4. The horizontal cable manager shall be sized to match cabling requirements. Provide a minimum of 2U of horizontal cable management for every 2U of connectivity. Cables must be able to access the cable manager so that no ports are blocked by the cables.

5. A single horizontal cable manager may be used to support multiple patch panels as long as it is sized to match cable fill requirements. Cables must be able to access the cable manager so that no ports are blocked by the cables.
6. The horizontal cable manager shall be a single-sided C-shaped trough with a cover. 2U high cable managers shall have three edge-protected oval openings at the rear to facilitate front-to-rear cabling through the horizontal manager. The front of the cable manager shall have T-shaped cable guides along the top and bottom surfaces of the cable manager. Evenly spaced cable openings in between the T-shaped cable guides shall allow cables to enter/exit the cable manager from/into the rack-mount space. The cover shall be removable, hinged to open up or down and shall snap on to secure the cover in the closed position.
7. The horizontal cable manager shall be delivered individually boxed, and available in the width(s) and height(s) as specified below and in the contract documents.
8. The horizontal cable manager shall be manufactured from steel, aluminum and plastic.
9. Finish shall be epoxy-polyester hybrid powder coat paint in the color as specified below and in the contract documents. Edge-protectors, T-shaped cable guides and latch hardware is black.
10. Acceptable products:
    a. Chatsworth Products, Inc. (CPI), Velocity™ Horizontal Cable Management:
        1) Part Number 35441-702, Evolution Single-Sided Horizontal Cable Manager, 2U x 19inEIA x 8.2in Deep (208 mm), Black
    b. Panduit
    c. TE Connectivity (ADC Krone)
    d. Owner Approved Equivalent

2.3 LADDER RACK, SUPPORTS, AND ACCESSORIES

A. Ladder Rack (Cable Runway)
1. Ladder rack shall be manufactured from 3/8” wide by 1-1/2” high tubular steel.
2. Ladder rack (side stringers) will be 9’-11½“long. Cross members will be welded in between stringers on maximum 12” centers beginning 5-3/4” from one end so that there are a minimum 10 cross members per ladder rack. There will be a maximum 10-1/2” of open space in between each cross member.
3. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified below.
4. Refer to the drawing set to determine the width.
5. Acceptable products: (“xx” denotes nominal width)
    a. Chatsworth 10250-7xx
    b. Cooper B-Line SB17TxxBFB
    c. Owner Approved Equivalent

B. Horizontal 90° Turns
1. Horizontal 90° turns shall be manufactured from 3/8” wide by 1-1/2” high tubular steel with .065” wall thickness.
2. Stringers (sides) will be formed in a 90° arc. Cross members will be welded in between stringers on approximate 23° increments so that there are 5 cross members per turn. The welded assembly will have a 15” inside radius and will create a smooth horizontal 90° turn.
3. Horizontal 90° turns will be available in the width(s) specified below.
4. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified below.
5. Acceptable products: (“xx” denotes nominal width)
    a. Chatsworth 10822-7xx
    b. Cooper B-Line SB17HRBxxFB
    c. Owner Approved Equivalent

C. Vertical-To-Horizontal 90° Turns
1. Vertical-to-horizontal 90° turns shall be manufactured from 3/8” wide by 1-1/2” high tubular steel with .065” wall thickness.
2. Stringers (sides) will be formed in a 90° arc with a 12-1/2” outside radius. Cross members will be welded in between stringers on approximate 23° increments so that there are 3 cross members per turn. The welded assembly will create a smooth 90° vertical-to-horizontal turn.
3. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified below.
4. Acceptable products: (“xx” denotes nominal width)
    a. Chatsworth 10724-7xx
    b. Cooper B-Line SB16VRBxxFB
    c. Owner Approved Equivalent

D. Corner Brackets

1. Corner brackets shall be manufactured from 3/8” wide by 1-1/2” high tubular steel with .065” wall thickness.
2. The inside stringers of the corner bracket will be formed at 90° with a small chamfer at the vertex. The outside stringer of the corner bracket will be formed in a 90° arc that is either 15” or 24” in radius. A single cross member will connect the chamfered portion of the inside stringer to the outside stringer. The welded assembly will create a smooth 90° turn within the L-shaped corner created by two intersecting ladder racks.
3. Corner brackets will be available in the size(s) specified below. Installation hardware will be included with the corner bracket. Corner bracket installation hardware does not include the junction splice kit required to form the L-shaped intersection between two ladder racks.
4. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color specified below.
5. Acceptable products: (“xx” denotes nominal radius)
   a. Chatsworth 11959-7xx
   b. Cooper B-Line SB2104FB
   c. Owner Approved Equivalent

E. Ladder Rack Splices
1. Splice kits will provide a method of mechanically connecting ladder rack sections and turns together end-to-end or side-to-end to form a continuous pathway for cables.
2. Grounding kits will provide a method of bonding ladder rack sections and turns together that is independent of the pathway splices. The grounding kit should be constructed of UL Listed components. The preferred solution is a #6 AWG green insulated stranded copper conductor connected on both ends to ladder rack using two-hole compression lugs and stainless steel hardware.
3. An insulator bar kit will provide a means of electrically isolating individual ladder rack sections through an end-to-end splice separated with a non-conductive material. The preferred solution is a 3/8” wide by 1-1/2” high by 5-1/2” long insulator bar made of Delrin® (by DuPont, Delrin is a registered trademark of E.I. du Pont de Nemours and Company).
4. Splices (splice plates) will be manufactured from steel. Splice, grounding and insulator bar kits will include installation hardware.
5. Finish (of splice plates and hardware) shall be zinc plate in the color(s) specified below. Colors are applied as a chem. film over the zinc plate.
6. Acceptable products:
   a. Chatsworth Products, Inc. (CPI)
      1) 11301-701 Butt Splice Kit
      2) 11302-701 Junction Splice Kit
   b. Cooper B-Line
      1) SB2107BZ Butt Splice Kit
      2) SB2101ABZ Junction Splice Kit
   c. Owner Approved Equivalent

F. Ladder Rack Supports
1. Supports will be sized to match the width of the ladder rack that is supported. Some supports will Work with all widths of ladder rack.
2. Each support will include a means of securing ladder rack to the support.
3. Supports will be manufactured from steel or aluminum.
4. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified below or zinc plate with a gold chem. finish specified gold. Included hardware shall be zinc plated with a gold chem. finish.
5. Acceptable products:
   a. Chatsworth Products, Inc. (CPI) (“xx” denotes nominal width)
      1) 11312-7xx Triangular Support Bracket
      2) 11421-7xx Wall Angle Support Kit
      3) 11310-001 Threaded Ceiling Kit, 3/8" Rod
      4) 10595-7xx Rack-To-Runway Mounting Plate
   b. Cooper B-Line
      1) SB213xxKFB Triangular Support Bracket
      2) SB2113xxFB Wall Angle Support Kit
      3) SB2221BZ Threaded Ceiling Kit, 3/8" Rod
      4) SB2133xxFB Rack-To-Runway Mounting Plate
   c. Owner Approved Equivalent

G. Ladder Rack Accessories
1. Provide end caps to cover exposed ladder rack ends.

a. End caps used to cover the ends of ladder rack will be manufactured from a black fire-retardant rubberized material. End caps will be sized for 3/8" wide by 1-1/2" high side stingers and will be sold in pairs.

2. Provide one radius drop for each rack and cabinet and stringer mounted radius drops, as required.
   a. Radius drops used to create a radius to form cables over as the cables exit or enter the ladder rack will be manufactured from aluminum extrusion. The extrusion will be formed in a 90° arc with a minimum bend radius of 3". Radius drops will attach to either the side stringer or the cross member of the ladder rack using a clevis pin. Radius drops will include 1-1/2" high cable spools that attach to the top of the radius drop to guide cables.
3. Provide moveable cross members, as required.
   a. Movable cross members used to support cross member radius drops in between welded cross members on ladder rack will be manufactured from 3/8" by 1-1/2" aluminum bar. Movable cross members will attach to ladder rack at the side stringers with included hardware so that the location of the movable cross member can be adjusted. Moveable cross member will support a cross member radius drop.
4. Touch-up paint used on ladder rack and ladder rack system components will be color-matched to the finish on the ladder rack or component. A spray on and brush on option will be available.
5. Unless otherwise noted, finish on all metal components shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified below. Hardware will be zinc plated with a gold chem. finish.
6. Acceptable products: ("xx" denotes nominal width)
   a. Chatsworth Products, Inc. (CPI)
      1) 10642-001 Cable Runway Protective End Caps
      2) 12100-7xx Radius Drop, Cross Member
      3) 12101-7xx Radius Drop, Stringer
      4) 12115-7xx Moveable Cross Member
   b. Cooper B-Line
      1) SB110A1B Cable Runway Protective End Caps
      2) SB2129xxFB Radius Drop, Cross Member
      3) SB2120DSxxFB Radius Drop, Stringer
      4) SB17RKxxFB Moveable Cross Member
   c. Owner Approved Equivalent

2.4 BACKBOARDS

A. Plywood, A/C, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with Requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

B. Paint all sides of each plywood backboard with white or gray fire-retardant paint. Do not paint over fire retardant stamp.

C. Install plywood vertically from 12" AFF.

2.5 UPS

A. Provide (1) UPS per rack or cabinet. UPS to be rack mounted (2RU) and have surge protection a 6-millisecond switchover time and a run time of 6.6 minutes at full load

B. Input power connection 110/120V AC with input connection NEMA 5-20 P. Contractor shall supply a cord to reach from the bottom of the rack where the UPS is mounted to the ladder rack where the electrical circuit is located. Cord length to be approx. 10" long, contractor to field verify once the power is installed.

C. Output Power is NEMA 5-20R x 2 and NEMA 5-15R x 6

D. Remote management interface is a USB for EPO switch and a RS-232 cable for management.

E. Acceptable products
   1. APC Smart UPS SMT2200RM2UC with smart connect
   2. APC Smart UPS SRT 3000VA RM
   3. APC two post rail kit for Smart UPS

PART 3 – EXECUTION

3.1 INSTALLATION

A. The installation recommendations contained within ANSI/TIA-568-C.1, ANSI/TIA-569 E and the BICSI Telecommunications Distribution Methods Manual (TDMM), including the Manufacturer's recommended installation methods or practices for a Standards-based Structured Cabling System, are mandatory minimum standards and requirements.

B. Mount equipment and enclosures plumb and level. Permanently installed equipment to be firmly and safely held in place. Equipment supports must support loads imposed with a safety factor of at least five.

C. Relay Racks
1. Assemble relay racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
2. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below.
3. Racks shall be grounded to the TGB using appropriate hardware provided by the contractor. The ground will meet local code requirements and will be approved by the AHJ.
4. In seismic areas, the rack should have additional bracing as required by building codes and the recommendations of a licensed structural engineer.
5. Ladder rack may be attached to the top of the rack to deliver cables to the rack. The rack should not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.
6. The equipment load should be evenly distributed and uniform on the rack. Place large and heavy equipment towards the bottom of the rack. Secure all equipment to the rack with equipment mounting screws.

D. Vertical Cable Managers
1. When more than one cable manager is used on a rack/frame or group of racks/frames, use the same make, style and size of vertical cable manager on the rack/frame or in between racks/frames.
2. The color of the rack(s)/frame(s) and cable manager(s) must match.
3. Attach vertical cable managers to the side of the rack/frame using the manufacturer's installation instructions and included hardware.
4. When a single vertical cable manager is used in between two racks/frames, attach the vertical cable manager to both racks/frames.
5. Dress cables through the openings in between the T-shaped guides on the manager so that cables make gradual bends as they exit or enter the cable manager into the rack-mount space (U). Do not twist, coil or make sharp bends in cables.
6. Doors shall be attached to the cable manager and in the closed position after cabling is complete.

E. Horizontal Cable Managers
1. When more than one horizontal cable manager is used on a rack/frame or group of racks/frames, use the same make and style of cable manager on the rack/frame or racks/frames.
2. The color of the rack(s)/frame(s) and cable manager(s) must match.
3. Attach horizontal cable managers to the rack/frame with four screws according to the manufacturer's installation instructions. Each cable manager shall be centered within the allocated rack-mount space (U).
4. Horizontal managers shall be located so that the number of ports (cables) that each manager supports shall not exceed each cable manager's cable fill capacity.
5. Dress cables through the openings in between the T-shaped guides on the cable manager so that cables make gradual bends as they exit or enter the cable manager into the rack-mount space (U). Do not twist, coil or make sharp bends in cables.
6. Covers shall be attached to the cable manager and in the closed position after cabling is complete.

F. Cable Tray and Ladder Rack
1. Provide all components of the ladder rack system (ladder rack, turns, splices, supports, and accessories) from a single manufacturer.
2. Ladder rack shall be installed with side stringers facing down so that the ladder forms an inverted U-shape and so that welds between the stringers (sides) and cross members (middle) face away from cables.
3. Ladder rack shall be secured to the structural ceiling, building truss system, wall, and the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).
4. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.

5. Ladder rack shall be supported every 5’ or less in accordance with TIA-569-B. Ladder rack shall be supported within 2’ of every splice and within 2’ on both/all sides of every intersection. Support ladder rack within 2’ on both sides of every change in elevation. Support ladder rack every 2’ when attached vertically to a wall.
6. Heavy-duty splices are recommended for ladder rack in excess of 18” width (18” wide ladder rack). Heavy-duty splices are required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns. Use heavy-duty splices to secure all overhead turns to the overhead horizontal pathway(s).
7. When the pathway is overhead, ladder rack shall be installed with a minimum clearance of 12” above the ladder rack. Leave a minimum of 12” in between ladder rack and ceiling/building truss structure. Leave a minimum of 3” in between ladder rack and the tops of equipment racks and/or cabinets. Multiple tiers of ladder rack shall be installed with a minimum clearance of 12” in between each tier of ladder rack. When located above an acoustical drop ceiling, leave a minimum of 3” clearance between the top of the drop ceiling tiles and the bottom of the ladder rack.
8. When installed under a raised floor, ladder rack shall be installed with a minimum 3” clearance between the top of the ladder rack and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3” clearance between ladder racks wherever ladder racks cross.
9. Within each telecommunications room, ladder rack should be bonded together, electrically continuous, and bonded to the TGB, unless otherwise noted in the specifications and contract documents. Ladder rack and turns shall be bonded across each splice with a bonding kit. Ladder rack shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the AHJ. Remove paint from the ladder rack where bonding/ground lugs contact the ladder rack so that the lug will contact bare metal. Use antioxidant joint compound in between the bare metal on the ladder rack and ground lug. Use antioxidant joint compound in between the bus bar and the ground lug. Verify continuity through the bonds at splices and intersections between individual ladder rack sections and turns and through the bond to the TGB.
10. The quantity of cables within the ladder rack will not exceed a whole number value equal to 50% of the interior area of the ladder rack divided by the cross-sectional area of the cable. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2”, unless cable retaining posts are added to the ladder rack. The interior area of ladder rack equipped with cable retaining posts will be considered to be the width of the ladder rack multiplied by a height of 6”. Actual cable fill for ladder rack that is not equipped with cable retaining posts will not exceed 2” in height. Actual cable fill for ladder rack equipped with cable retaining posts will not exceed 6” in height.
11. The combined weight of cables within the ladder rack will not exceed the stated load capacity of the ladder rack as stated in the manufacturer’s product specifications or load/design tables.
12. Cables (cable bundles) will be secured to the cross members of ladder rack with ¾” wide reusable straps. Straps are not required when ladder rack is equipped with cable retaining posts.
13. Add 8” high cable retaining posts to the open sides of ladder rack when cable fill exceeds 2” in height or when cable bundles cannot be secured directly to the ladder rack cross members with a strap. Cable fill within any ladder rack should not exceed 6” in height.
14. When a single ladder rack supports different types of cable media, the cable media will be separated within the pathway by cable spools that attach to the cross members on the ladder rack. Treat each type of cable media and divided area of the ladder rack separately when determining cable fill limits.
15. Use a radius drop to guide cables wherever cable exits overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field. If necessary, provide a moveable cross member also to attach and align the radius drop in between the welded cross members of a ladder rack.
16. Cover the exposed ends of cable runway that do not terminate against a wall, the floor or the ceiling with end caps or an end closing kit.
17. Use auxiliary support brackets that attach to the side stringer of the ladder rack to support interconnect cabling (patch cords, equipment cords, jumper cords) that is routed between racks using the ladder rack. Auxiliary support brackets can be used to support other conductors that should be physically separated from cables within the ladder rack as defined by local code or the authority having jurisdiction (AHJ).
18. Whenever possible, maintain a 2’ separation between ladder rack used for communications cables and pathways for other utilities or building services.
19. The installer will provide touch-up paint color-matched to the finish on the ladder rack and will correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is

physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.

3.2 AC POWER AND GROUNDING

A. Coordinate and verify final connection of related electrical power, TMGB and TMB Grounding Busbar and ground conductors.

B. Provide ground system compliant with the reference ANSI/TIA-607-D Standard, ANSI/NFPA-70 and authorities having jurisdiction.

C. Ground equipment chassis not having a three-wire power cord, other metal enclosures, and equipment rack frames in the ER and IDF room(s) to the ground bus bar in that room using # 6 AWG insulated conductor and bonding with 10/32 nuts, bolts and lock-washers.

D. Remove any finish and make-bare any metallic surface at the point where grounding wire is connected to and or terminated on equipment frames, racks or devices.

END OF SECTION

SECTION 27 13 00

COMMUNICATIONS BACKBONE CABLING

PART 1 – GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes the minimum requirements for the installation of backbone cabling between Telecommunications Rooms.

C. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Conventional Fiber Optic Cabling
   2. Fiber Optic Splicing and Termination Hardware
   3. Fiber Enclosures, Adapter Panels and Splice Trays
   4. Fiber Optic Patch Cords.

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:
   1. ANSI American National Standards Institute
   2. BICSI Building Industry Consulting Service International
   3. CMR Communications Riser Cable
   4. CMP Communications Plenum Cable
   5. DCM Design Criteria Manual
   6. EIA Electronics Industries Alliance
   7. FOCIS Fiber Optic Connector Intermateability Standards
   8. ICEA Insulated Cable Engineers Association
   9. IDC Insulation Displacement Connector
   10. IEEE Institute of Electrical and Electronics Engineers
   11. MER Main Equipment Room
   12. NECA National Electrical Contractors Association
   13. NEMA National Electric Manufacturers Association
   14. NFPA National Fire Protection Association
   15. OAR Owner’s Authorized Representative
   16. OLTS Optical Loss Test Set
   17. OFNR Optical Fiber Nonconductive Riser
   18. RCDD Registered Communications Distribution Designer
   19. RFP Request for Proposal
   20. STD Standard
   21. TIA Telecommunications Industry Association
   22. TR Telecommunications Room
   23. TSA Transportation Security Administration
   24. UL Underwriters Laboratories
   25. UTP Unshielded Twisted Pair

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the OAR.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the OAR.

C. Strictly adhere to all BICSI, EIA and TIA recommended installation practices when installing communications backbone cabling.

D. Contractor's Qualifications:
1. Firms regularly engaged in the installation of Data Communications cabling and that have five (5) years of installation experience with systems similar to that required for this project.
2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked and the clients will be asked questions relative to the performance of your company.
3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.
4. Provide a BICSI RCDD certified professional for oversight on this project. This person does not have to be working on-site, but must be accessible to answer questions and provide weekly status reports. The RCDD shall be a full-time employee of the contractor.
5. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the OAR.

E. Manufacturer's Qualifications:
1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

F. Material and Work specified herein shall comply with the applicable requirements of:
1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2010
2. ANSI/NECA/BICSI-568 – Standard for Installing Commercial Building Telecommunications Cabling, 2006
3. ANSI/TIA-568-.0-D – Generic Telecommunications Cabling for Customer Premises, 2009
4. ANSI/TIA-568-0.D-1 – Telecommunications Cabling for Customer Premises – Addendum 1, Updated reference for balanced twisted Pair Cabling, 2010
5. ANSI/TIA-568.1-D – Commercial Building Telecommunications Cabling Standard, 2015
6. ANSI/TIA-568.2-D – Balanced Twisted-Pair Telecommunications Cabling and Components Standards, 2018
7. ANSI/TIA-568.3-D – Optical Fiber Cabling Components Standard, 2016
8. ANSI/TIA-526-7-A, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant
9. ANSI/TIA-569-E – Commercial Building Standard for Telecommunications Pathways and Spaces, 2019
10. ANSI/TIA-606-C – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2017
11. ANSI/TIA-607-D – Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2007
12. ANSI/TIA-942 – Telecommunications Infrastructure Standard for Data Centers
13. NFPA 70 – National Electric Code, 2017
14. UL 13 – Standard for Safety for Power-Limited Circuit Cables
15. UL 444 – Standard for Safety for Communications Cables
16. BICSI – Telecommunications Distribution Methods Manual, 13th Edition
17. IEEE 802 – Local Area Network Standard
18. Applicable codes and directives of authorities having jurisdiction

G. Work:
1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the OAR in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The OAR must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the OAR in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Produce Shop Drawings for ALL backbone cabling, to include but not limited to, proposed routing and its location relative to building structure (columns, floor or ceiling) and its relationship to electrical, mechanical elements.

D. Provide all submittal requirements under this section as a single package.

E. Provide product data for the following:
   1. Product data consisting of manufacturers specifications for each type of product to be installed, all applicable certifications and elevation/plan documents supporting compliance with stated Specifications.
   2. Manufacturer’s certificate of acceptance of the qualifications of the installing Contractor to install, test and maintain the manufacturer’s equipment.
   3. Manufacturer’s installation specifications for copper cabling and optical fiber, indicating minimum bend radius and maximum pull tension.
   4. Outline of administration labeling scheme for voice and data communications cabling and termination locations per ANSI/TIA-606.
   5. Proposed format of as-built documentation

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (4) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. Test reports on all copper and optical fiber cables (electronic file format and hard copy).
   3. As-built cable schedules with recorded cable routing and lengths of each designated run.
   4. As built documentation of all cabling systems.
   5. As built documentation of all pathway systems to include cable tray, conduits (horizontal and vertical), and non-contiguous support.
   6. As built documentation of TR modifications and associated cabinet elevations.
   7. Laminated as-built drawing sheet of TR service area, with a scale of not less than 1/8 inch, mounted in the wall of each TR.

B. Warranty and Maintenance:
   1. Test Report Binder(s)
   2. Record Drawings

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer's recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics, following Contractor Warranty requirements defined in Division 01, or for a period of 1 year from date of final completion, whichever is longer. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

PART 2 – PRODUCTS

2.1 GENERAL

A. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

2.2 ACCEPTABLE DISTRIBUTORS

A. Contractor shall procure all horizontal cabling components through authorized Manufacturer product distributors.

2.3 ACCEPTABLE VENDORS AND MATERIALS

A. Subject to compliance with requirements, install products from the following manufacturers, except where noted:
   1. Cable, Copper
      a. General Cable Technologies Corp.
      b. Superior Essex Inc.
      c. Owner approved equivalent
   2. Cable, Fiber Optic
      a. Corning
      b. Owner approved equivalent
   3. Termination Components
      a. Panduit Corp.

B. Part numbers are provided for convenience purposes only; the contractor is responsible for complete material list and quantities. All materials listed are manufactured by General, Superior Essex or Corning unless otherwise noted. Colors are to be approved by Owner.

2.4 UTP PRODUCTS

1. UTP Cable
   1. Provide multi-pair Category 3 cabling for all copper backbone connectivity.
   2. Conductors shall be 24 AWG solid annealed copper.
   3. Pairs shall be formed into 25-pair binder groups.
   4. The jacket shall be constructed of flame retardant PVC.
   5. Comply with ICEA S-90-661 for mechanical properties.
   6. Comply with ANSI/TIA-568-C.1 & ANSI/TIA-568-C.2 for performance specifications.
   7. Provide plenum-rated cable for all plenum environments and riser-rated cable for all non-plenum environments.
   8. Provide outdoor rated cable for any cable that leaves the building
   9. Approved products:
      1. General Cable Category 3 Plenum
      2. General Cable Category 3 Non-Plenum
      3. Superior Essex Category 3 CMR/CMP
      4. Owner approved equivalent.

2. UTP Cable Terminating Hardware
   1. Terminate each end of copper backbone cables with rack mount 110 style field termination kits.
   2. Hardware to exceed the TIA/EIA-568-B.2 Category 3 standard.
   3. Hardware to be field terminable.
   4. Include required quantity of bases and connecting blocks, label holders and labels.
   5. Kit shall include jumper troughs.
   6. Connecting blocks shall be of the 5-pair variety.
   7. Acceptable products:
      1. Panduit P110B1005R4WJY 110 Punchdown Kit with Bases, 5 Pair Connector Blocks, Jumper Troughs
      2. Owner approved equivalent.

3. UTP OSP Primary protection

1. Every pair of incoming copper cable Shall be protected.
2. Hardware to exceed UL497 Primary protection standards
3. External ground is required #6-#14 AWG
4. 110 style connection for both the input and output.
5. Standard 5-pin protection modules required for every pair.
6. Acceptable products.
    1. Circa Telecom 1880ECA1-25
    2. Owner approved equivalent

2.5 FIBER OPTIC PRODUCTS

A. Single mode Fiber
    1. Provide singlemode fiber optic backbone cabling, as indicated in the drawing set.
    2. Optical fibers shall be minimum OS2 compliant.
    3. Maximum attenuation coefficient shall be:
        a. 0.65 dB/km at 1310 nm
        b. 0.65 dB/km at 1383 nm
        c. 0.65 dB/km at 1550 nm
    4. Provide plenum-rated cable for all plenum environments and riser-rated cable for all non-plenum environments.
    5. Jacket to be yellow in color.
    6. Jacket to be imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
    7. Refer to the drawing set for exact fiber counts.
    8. Approved products:
        a. Corning MIC® Interlocking Armored Plenum Cable
            1) xxxE88-31131-A3 (2-24 fibers)
            2) xxxE88-61131-A3 (36-48 fibers)
            3) xxxE88-T3131-A3 (60-144 fibers)
            4) Where xxx equals fiber strand count
        b. Corning FREEDN One Indoor/Outdoor Cable, riser.
            1) xxxT8F-yy191-29 (2-144 fibers)
            2) Where xxx equals fiber strand count
            3) Where yy corresponds to unit bundle counts
        c. Owner approved equivalent.

B. Fiber Optic Connectors
    1. Provide LC pigtail connectors to fusion splice to each fiber.
    2. Quick-connect, simplex or duplex, type LC connectors.
    3. Connector to comply with FOCIS specifications of TIA-604-10A
    4. Insertion loss of not more than 0.75 dB
    5. Acceptable Products:
        a. Panduit F9B10-NM1Y LC To Pigtail PC, Singlemode, 9µm Simple Buffered, 1m
        b. Owner approved equivalent

C. Fiber Optic Splice Module
    1. Provide fusion splice modules for fiber enclosures
    2. Modules shall accept up to 24 fusion splices.
    3. Modules shall be designed to install in rack mount fiber enclosures.
    4. Provide a quantity of modules to accommodate every splice within each enclosure.
    5. Acceptable products:
        a. Panduit FOSMH4U Fiber Optic Splice Module
        b. Panduit FOSMF Fiber Optic Splice Module for 24 Fusion Splices
        c. Owner approved equivalent

D. Fiber Enclosures
    1. Provide rack mount modular fiber enclosures.
    2. Enclosures shall accept splice modules and fiber adapter modules.
    3. Populate unused fiber adapter panel openings with blank filler plates.
    4. Refer to the drawing set to determine exact size and configuration.
    5. Acceptable Products:
        a. Panduit FRME1U Rack Mount Fiber Enclosure 1RU
        b. Panduit FRME2U Rack Mount Fiber Enclosure 2RU

c. Panduit FCE4U Rack Mount Fiber Enclosure 4RU
d. Owner approved equivalent

E. Fiber Adapter Panel
1. Provide LC duplex fiber adapter panels for fiber enclosures
2. Modules shall 12 duplex LC fibers.
3. Modules shall be designed to install in rack mount fiber enclosures.
4. Provide a quantity to accommodate every fiber within each enclosure
5. Acceptable products:
a. Panduit FAP12WBUDLCZ Fiber Adapter Panel, 12 duplex SM LC
b. Panduit FAPB Blank Fiber Adapter Panel
c. Owner approved equivalent

F. Fiber Optic Patch Cords
1. Provide factory-made, duplex fiber jumpers.
2. Singlemode jumpers shall be constructed of 8.3/125µm (OS1 minimum) fiber.
3. Provide a variety of lengths (1M, 2M and 3M), as needed, based on the rack elevations in the drawing set.
4. Provide a mixed variety of patch cord quantities for each closet. Provide a 50% ratio of terminated ports to patch cords of each type and an additional 20% for spares.
5. Acceptable Products:
a. Panduit F9E10-10MxY LC to LC Fiber Jumper, Duplex, 10 GbE Singlemode
b. Panduit F9E3-10MxY SC to LC Fiber Jumper, Duplex, 10 GbE Singlemode
c. Owner Approved Equivalent

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 conduits, raceways and cable trays.

B. Install plenum cable in environmental air spaces where cabling will be exposed, including plenum ceilings.

C. Bundle, lace, and train cables within racks and enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and wiring troughs, as required.

3.3 INSTALLATION OF CABLES

A. General Requirements for Cabling:
1. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Terminate all conductors; no cable shall contain unterminated elements.
4. UTP Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and no more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Verify that installed cable’s minimum bend radius does not exceed the installed conduit’s bend radius at any point. Coordinate any conduit bend radius conflicts with Installing/General Contractor prior to installation of cable.

3.4 POST-INSTALLATION TESTING

A. Contractor shall test each pair or strand of every cable prior to acceptance. (100% PASS)

B. Contractor shall supply all required test equipment used to conduct acceptance tests.

C. Contractor shall submit acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved.

D. Standards Compliance and Test Requirements:
   1. Copper backbone shall exceed ANSI/TIA-568-D.2 Backbone Cabling requirements and meet the manufacturer's specifications for the installed product.
   2. Optical fiber shall exceed ANSI/TIA-568-D.3 Optical Fiber Cabling Components Standard requirements and meet the manufacturer's specifications for the installed product.
   3. Contractor shall certify to TIA/TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.

E. Cable Test Documentation:
   1. Optical Fiber: Testing shall be performed on all fibers in the completed end-to-end system.
      a. Power Meter and Source Loss Reports: Testing shall consist of a bi-directional, dual wave length end to end test. The system loss measurements shall be provided at 850 and 1300 nanometers for multi-mode fibers and 1310 and 1550 for single mode fibers.
      b. Optical Time Domain Reflectometer (OTDR) Reports: Testing shall consist of a bi-directional end to end OTDR trace performed per TIA/EIA 455-61. Reflective events (connections) shall not exceed 0.75 dB.
      c. Non-reflective events (splices) shall not exceed 0.3 dB.
      d. Fibers shall be inspected at 250X or 400X magnification. 250X magnification is suitable for inspecting multimode and single mode fibers. 400X magnification may be used for detailed examination of single mode fibers.
      e. Testing shall be performed on each cabling segment (connector to connector).
      f. Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for optical loss test set (OLTS) testing shall be between one meter and five meters in length. The test cords for OTDR testing shall be approximately 100 meters for the launch cable and at least 25 meters for the receive cable.
      g. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
   2. Test results saved within the field-test instrument shall be transferred into a Windows™ based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   3. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information:
      a. The identification of the customer site as specified by the end-user.
      b. The name of the test limit selected to execute the stored test results.
      c. The name of the personnel performing the test.
      d. The date and time the test results were saved.
      e. The manufacturer, model and serial number of the test instrument.
      f. The version of the test software and the version of the test limit database held within the test instrument.
      g. The fiber identification number.
      h. The length for each optical fiber.
      i. The index of refraction used for length calculation when using a length capable OLTS.
      j. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
      k. Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
      l. The length for each optical fiber as calculated by the OTDR
      m. Overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements.
      n. Circuit IDs reported by the test instrument should match the specified label ID.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections in accordance with project specifications. Provide minimum 24 hours notice to OAR prior to testing. All testing shall be witnessed by OAR, at OAR's discretion.

B. Tests and Inspections:
   1. Furnish proposed test procedures, recording forms, list of testing personnel and test equipment to OAR for review prior to commencement of testing.
   2. Follow recommended procedures for testing as published by test equipment manufacturer.

C. Optical Fiber Testing with OTDR

1. The Contractor shall test all optical fiber cable prior to installation. The Contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.
2. All fiber testing shall be performed on all fibers in the completed system. Bidirectional end-to-end OTDR testing shall be performed in accordance with TIA 455-78-B. The system loss measurement shall be provided at 850 and 1310 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.
3. Fiber links shall have a maximum loss of (allowable cable loss per km) (km of fiber in the link) + (.4dB)(number of mated connectors) = maximum allowable loss.
4. Documentation shall be provided in both hard copy and CD format to the OAR.

D. Optical Fiber Testing with Power Meter
1. Multimode Horizontal Link Segments should be tested in both directions at 850-nm and 1300-nm wavelengths.
2. Multimode backbone and composite link segments should be tested in both directions at both 850-nm and 1300-nm wavelengths.
3. Singlemode horizontal link segments shall be tested in both directions at 1300-nm and 1550-nm wavelengths.
4. Singlemode backbone and composite link segments should be tested in both direction at both 1310-nm and 1550-nm wavelengths.

E. Testing documentation shall be submitted in accordance with TIA/EIA 526-14-A “Optical Power Loss Measurement in Installed Multimode Fiber Cable Plant” and TIA/EIA 526-7 “Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant”. At minimum, the following information shall be documented during testing:
1. Names of personnel conducting the test.
2. Type of test equipment used (manufacturer, model, serial number).
3. Date test is being performed.
4. Fiber identification.
5. End point locations.
6. Test direction.
7. Reference power measurement (when not using a power meter with a relative power measurement mode).
8. Measured attenuation of the link segment.
9. Acceptable link attenuation.
10. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

END OF SECTION

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SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 – GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes the minimum requirements for the installation of horizontal cabling between Telecommunications Rooms and Work Area Outlets.

C. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Category 6 and Category 6A Cable
   2. Faceplates, Jacks, and Modules
   3. Patch Panels
   4. Patch Cords
   5. Cable Ties

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:
   1. ANSI American National Standards Institute
   2. AWG American Wire Gauge
   3. BICSI Building Industry Consulting Service International
   4. CMR Communications Riser Cable
   5. CMP Communications Plenum Cable
   6. DCM Design Criteria Manual
   7. EIA Electronics Industries Alliance
   8. FEP Fluorinated Ethylene Propylene
   9. IDC Insulation Displacement Connector
   10. IEC International Electrotechnical Commission
   11. IEEE Institute of Electrical and Electronics Engineers
   12. ISO International Standards Organization
   13. MER Main Equipment Room
   14. NEMA National Electric Manufacturers Association
   15. NEXT Near End Crosstalk
   16. NFPA National Fire Protection Association
   17. OAR Owner’s Authorized Representative
   18. PCI Panduit Certified Installer
   19. RCDD Registered Communications Distribution Designer
   20. RFP Request for Proposal
   21. RL Return Loss
   22. STD Standard
   23. STP Shielded Twisted Pair
   24. TIA Telecommunications Industry Association
   25. TR Telecommunications Room
   26. TSA Transportation Security Administration
   27. TSB Technical Services Bulletin
   28. UL Underwriters Laboratories
   29. UTP Unshielded Twisted Pair

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the OAR.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the OAR.

C. Strictly adhere to all BICSI, EIA and TIA recommended installation practices when installing communications cabling.

D. Contractor’s Qualifications:
   1. Firms regularly engaged in the installation of Data Communications cabling and that have five (5) years of installation experience with systems similar to that required for this project.
   2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked, and the clients will be asked questions relative to the performance of your company.
   3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.
   4. Provide a BICSI RCDD certified professional for oversight on this project. This person does not have to be working on-site but must be accessible to answer questions and provide weekly status reports. The RCDD shall be a full-time employee of the contractor.
   5. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the OAR.

E. Manufacturer’s Qualifications:
   1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

F. Material and Work specified herein shall comply with the applicable requirements of:
   1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2015
   2. ANSI/NECA/BICSI-568 – Standard for Installing Commercial Building Telecommunications Cabling, 2006
   3. ANSI/TIA-568-D.0 – Generic Telecommunications Cabling for Customer Premises, 2015
   4. ANSI/TIA-568-D.1 – Commercial Building Telecommunications Cabling Standard, 2017
   5. ANSI/TIA-568-D.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards, 2015
   6. ANSI/TIA-568-D.3 – Optical Fiber Cabling Components Standard, 2019
   7. ANSI/TIA-569-E Commercial Building Standard for Telecommunications Pathways and Spaces, 2019
   8. ANSI/TIA-606-C – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012
   9. ANSI/TIA-607-D – Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2019
   10. ANSI/TIA-942 – Telecommunications Infrastructure Standard for Data Centers
   11. NFPA 70 – National Electric Code, 2017
   12. UL 13 – Standard for Safety for Power-Limited Circuit Cables
   13. UL 444– Standard for Safety for Communications Cables
   14. BICSI – Telecommunications Distribution Methods Manual, 13th Edition
   15. IEEE 802 – Local Area Network Standard
   16. Applicable codes and directives of authorities having jurisdiction

G. Work:
   1. The Work shall be performed in compliance with the applicable manufacturer’s installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
   2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
   3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
   4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the OAR in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The OAR must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the OAR in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Produce Shop Drawings for ALL horizontal cabling, to include but not limited to, proposed routing and its location relative to building structure (columns, floor or ceiling) and its relationship to electrical, mechanical elements as well as any horizontal cables that may exceed 295’ in length (including service loops).

D. Provide all submittal requirements under this section as a single package.

E. Provide product data for the following:
   1. Product data consisting of manufacturers specifications for each type of product to be installed, all applicable certifications and elevation/plan documents supporting compliance with stated Specifications.
   2. Manufacturer’s certificate of acceptance of the qualifications of the installing Contractor to install, test and maintain the manufacturer’s equipment.
   3. Manufacturer’s installation specifications for UTP cabling and optical fiber, indicating minimum bend radius and maximum pull tension.
   4. Outline of administration labeling scheme for voice and data communications cabling and termination locations per ANSI/EIA/TIA-606.
   5. Proposed format of as-built documentation.

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (4) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. Test reports on all copper and optical fiber cables (electronic file format and hard copy).
   3. As-built cable schedules with recorded cable routing and lengths of each designated run.
   4. As built documentation of all cabling systems.
   5. As built documentation of IDF/TR modifications and associated cabinet elevations.
   6. Laminated as-built drawing sheet of TR service area representing each level, with a scale of not less than 1/8in, mounted on the wall of each TR.

B. Warranty and Maintenance:
   1. Test Report Binder(s)
   2. Record Drawings

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer's recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics, following Contractor Warranty requirements defined in Division 01, or for a period of 1 year from date of final completion, whichever is longer. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

C. In addition to the warranty outlined above, the Contractor shall facilitate a warranty between the Owner and the Manufacturer that provides coverage of the installed cabling system for a period of (25) twenty-five years (Panduit Certification Plus System Warranty). This warranty will cover the installed horizontal cabling system (Patch Panel to Workstation). Category 6 copper links originating from patch panels shall be warranted against the link performance minimum expected results defined in the ANSI/TIA

Telecommunications Systems Bulletin (TSB-67), now incorporated into TIA 568-B, for Category 6 performance requirements. Category 6 copper links originating from wall mounted 110-style termination blocks shall be warranted against link performance minimum expected results for Category 6 performance requirements. Installation shall be performed by a Panduit Certified Installer.

PART 2 – PRODUCTS

2.1 GENERAL

A. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

2.2 ACCEPTABLE DISTRIBUTORS

A. Contractor shall procure all horizontal cabling components thru an approved cabling system Manufacturer product distributor.

2.3 ACCEPTABLE VENDORS AND MATERIALS

A. Subject to compliance with requirements, install products from the following manufacturers, except where noted:
   1. Cable, Copper
      a. Panduit Corp.
   2. Termination Components
      a. Panduit Corp.

B. Part numbers are provided for convenience purposes only; the contractor is responsible for complete material list and quantities. All materials listed are manufactured by Panduit, unless otherwise noted. Colors shall be approved by Owner.

C. Cable Jacket, patch cable, and Jack colors shall match Eagle Mountain Saginaw ISD standard
   1. Red – Voice
   2. Blue – Data
   3. Green – Wi-Fi
   4. Violet –Printer/copiers, Security
   5. Gray- Speakers

2.4 CATEGORY 6A PRODUCTS

1. UTP Cable
   1. Provide Category 6A cabling for all wireless access point outlets.
   2. Cable shall exceed requirements of ANSI/TIA-568-C.2, ISO 11801 Class EA Edition 2.1, and IEEE 802.3an-2006 standard channel requirements for supporting 10GBASE-T, and be third party tested to 650 MHz.
   3. The conductors shall be 23 AWG construction with FEP (CMP) insulation.
   4. The copper conductors shall be twisted in pairs, separated by internal dividers to improve NEXT performance, and shall be covered by a low smoke, flame retardant (CMP) jacket.
   5. The jacket colors for cables shall be Eagle Mountain Saginaw ISD standard.
   6. Approved products:
      1. Panduit PUP6A04xx-UG TX6™ 10Gig™ Category 6A UTP Copper Cable, Plenum
      2. Owner approved equivalent

2. UTP Jack Modules
   1. Provide Category 6A jack modules to terminate both ends of each Category 6A horizontal cable.
   2. Module shall exceed requirements of ANSI/TIA-568-C.2, ISO 11801 Class EA Edition 2.1, and IEEE 802.3an-2006 standard channel requirements for supporting 10GBASE-T component standards.
   3. Module shall meet requirements of IEEE 802.af and IEEE 802.3at for Power over Ethernet (PoE) applications.

4. Module shall be 100% tested to ensure NEXT and RL performance and be individually serialized for traceability.
5. Modules at work area outlet locations shall match Eagle Mountain Saginaw ISD standards in color.
6. Modules in patch panels shall match Eagle Mountain Saginaw ISD standards in color.
7. Approved products:
    1. Panduit CJ6X88TG Mini-Com® TX6™ 10Gig™ UTP Jack Module
    2. Owner approved equivalent

3. Copper Patch Cords
    1. Provide Category 6A patch cords for patching within the MDF or TR.
    2. Patch cord shall exceed requirements of ANSI/TIA-568-C.2 Category 6A, IEEE 802.3an-2006, and ISO 11801 Class EA channel standards.
    3. Shall meet requirements of IEEE 802.af and IEEE 802.3at for PoE applications.
    4. Each patch cord shall be 100% performance tested and wired T568B.
    5. Patch cord shall be constructed of TX6A™ 10Gig™ 24 AWG stranded copper cable and TX6™ PLUS Modular Plugs for superior performance.
    6. Patch cord plugs shall meet all applicable ANSI/TIA-968-A requirements and exceeds IEC 60603-7 specifications.
    7. Plugs shall use an integral pair manager to optimize performance and consistency by reducing untwisting of conductors within the plug.
    8. Patch cord shall perform in center of TIA/EIA component range, ensuring interoperability and 10GBASE-T Ethernet channel performance.
    9. Patch cord shall be labeled with an identification of performance level, length, and a quality control number.
    10. Provide a variety of 5’, 7’ and 10’ length patch cords. Include a quantity necessary to patch every available patch panel port:
    11. 25% of the patch cords are to be 5' in length.
    12. 50% of the patch cords are to be 7' in length.
    13. 25% of the patch cords are to be 10' in length.
    14. Patch cords shall match color of system (Eagle Mountain Saginaw ISD color standard).
    15. Approved products:
        1. Panduit UTP6A5 Category 6A Copper Patch Cord, 5’
        2. Panduit UTP6A7 Category 6A Copper Patch Cord, 7’
        3. Panduit UTP6A10 Category 6A Copper Patch Cord, 10’
        4. Owner approved equivalent.

2.5 CATEGORY 6 PRODUCTS

A. UTP Cable (Voice/Data)
    1. Provide Category 6 cabling for all voice and data work area outlet locations.
    2. Cable shall far exceed ANSI/TIA/EIA-568-B.2-1 and ISO/IEC 11801 Class E standards.
    3. The conductors shall be 23 AWG construction with FEP (CMP) or polyolefin (CMR) insulation.
    4. The copper conductors shall be twisted in pairs, separated by an integrated pair divider and shall be covered by a low smoke, flame retardant (CMP) jacket or a flame retardant (CMR) jacket.
    5. Provide plenum-rated cable for all plenum environments and riser-rated cable for all non-plenum environments.
    6. The jacket colors for cables shall be Eagle Mountain Saginaw ISD standard.
    7. Approved products:
        a. Panduit PUP6504xx-UY TX6500™ Category 6 UTP Copper Cable, Plenum
        b. Panduit PUR6504xx-UY TX6500™ Category 6 UTP Copper Cable, Non-Plenum
        c. Owner approved equivalent

B. UTP Jack Modules
    1. Provide Category 6 jack modules to terminate both ends of each horizontal cable.
    2. Module shall exceed requirements of ANSI/TIA-568-C.2 Category 6, IEEE 802.3an-2006, and ISO 11801 Class E channel standards and exceed requirements of ANSI/TIA-568-C.2 Category 6 and IEC 61156-5 Category 6 component standards.
    3. Module shall meet requirements of IEEE 802.af and IEEE 802.3at for Power over Ethernet (PoE) applications.

4. Module shall be 100% tested to ensure NEXT and RL performance and be individually serialized for traceability.
5. Modules at work area outlet locations shall match Eagle Mountain Saginaw ISD standards in color.
6. Modules in patch panels shall match Eagle Mountain Saginaw ISD standards in color.
7. Approved products:
   a. Panduit CJ688TG Mini-Com® TX6™ PLUS UTP Jack Module
   b. Owner approved equivalent

C. Category 6 Patch Cords
1. Provide Category 6 patch cords in MDF and TR.
2. Patch cords shall match color of system (Eagle Mountain Saginaw ISD color standard).
3. Patch cord shall exceed ANSI/TIA-568-C.2 Category 6 and ISO 11801 Class E standards.
4. Shall meet requirements of IEEE 802.af and IEEE 802.3at for PoE applications.
5. Each patch cord shall be 100% performance tested and wired T568B.
6. Patch cord shall be constructed of Category 6/6A, 24 AWG UTP stranded cable Modular RJ-45 Plugs.
7. Patch cord plugs shall meet all applicable ANSI/TIA/EIA-968-A requirements and exceeds IEC 60603-7 specifications.
8. Plugs shall use an integral pair manager to optimize performance and consistency by reducing untwisting of conductors within the plug.
9. Patch cord shall perform in center of TIA/EIA component range, ensuring interoperability and excellent performance.
10. Patch cord shall be labeled with an identification of performance level, length, and a quality control number.
11. Provide a 25% ratio quantity of each of the following lengths, 3’, 5’, 7’, 10’ patch cords for every port in the data rooms.
12. Approved products:
    a. Panduit UTPSP Category 6 Copper Patch Cord
    b. Panduit UPP Category 6 Plenum Rated Copper Patch Cord
    c. Owner approved equivalent

2.6 WORK AREA OUTLET PRODUCTS

A. Wall Mount Faceplates
1. Provide faceplates for voice and data work area outlets in all spaces. Match type (stainless steel/plastic) and color of electrical outlets.
2. Faceplate shall accept four (4) or six (6) modules for STP and UTP, fiber optic, and audio/video, which snap in and out for easy moves, adds, and changes.
3. Include label/label covers for easy port identification.
4. Approved products:
   a. Plastic/Stainless Steel Faceplate, 4-Port.
   b. Plastic/Stainless Steel Faceplate, 6-Port.
   c. Owner approved equivalent

B. Furniture System faceplates
1. Provide faceplates for work area outlet locations inside of modular furniture.
2. Shall accept Mini-Com® Modules for STP and UTP, fiber optic, and audio/video, which snap in and out for easy moves, adds, and changes.
3. Coordinate the exact faceplate assembly with the furniture manufacturer.
4. Faceplate shall be black in color.
5. Approved products:
   a. Panduit CFFP4BL Furniture Faceplate, 4 Port
   b. Owner approved equivalent.

C. In-Wall Outlet Boxes
1. Provide a galvanized steel sheet metal 4" x 4" x 2-1/8" deep, minimum, with single gang mud ring for each outlet location.

D. Surface Mount Outlet Box
1. Provide surface mount outlet boxes for work area outlet locations where outlets cannot be recessed.
2. Shall accept Jack Modules for STP and UTP, fiber optic, and audio/video, which snap in and out for easy moves, adds, and changes.
3. Mount easily with supplied mounting screws, adhesive tape or optional magnet.
4. Cable entry from side and rear knockouts and from opening in center of base.

5. Outlet box shall be white in color.
6. Approved products:
   a. Surface Mount Box, 2 Port
   b. Surface Mount Box, 4 Port

E. Blank Modules
1. Populate any unused faceplate module openings with blank modules.
2. Blank module color shall match the faceplate color.
3. Populate any unused patch panel module openings with blank modules.
4. Blank module color shall match the patch panel color.
5. Approved products:
   a. Blank Module

F. Patch Panels
1. Provide patch panels in TR locations for all horizontal cabling.
2. Patch panel shall contain integrated Category 6 or Category 6A Modules for UTP, fiber optic, and audio/video, on the front and integrated termination on the rear of the panel.
3. Use of two label pocket face plate allowing both port and panel identification.
4. Can be clearly identified with Hand-Held Thermal Transfer Printers.
5. Use 48-port patch panels in all locations.
6. Approved products:
   a. Patch Panel, 48 Port, Black

2.7 MISCELLANEOUS PRODUCTS

A. Cable Ties
1. Provide “hook & loop” cable ties for bundling cables.
2. The material shall consist of nylon loops with polypropylene hooks.
3. Use plenum-rated ties in plenum spaces.
4. Approved products:
   a. TE Connectivity (ADC KRONE)
   b. Panduit
   c. Or approved equal

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify conduit, raceways, boxes, fittings and bodies are properly installed as described in Division 26.

B. Verify grounding and bonding following Section 270526.

C. Verify supporting devices are properly installed following Section 270528.

D. Verify conduit has a minimum 1-inch diameter for UTP home runs.

E. All protected telecommunication terminations require bonding, grounding and a busbar.

3.2 INSTALLATION

A. General
1. Cables shall be pulled in accordance with the manufacturers recommended practices and in compliance with the NEC and the BICSI Telecommunications Distribution Methods Manual. Planning and care shall be taken to prevent abuse and damage during the handling or installation phase. Specified minimum cable bend radius shall be met without deviation.
2. Pull cables simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant where necessary. Compound used must not deteriorate conductor or insulation. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.
3. Protect cable from tension, compression, torsion, bending, squeezing and vibration. Do not pull cables improperly or exceed the Manufacturer’s tensile rating. This value shall be not more than thirty-two (32) lbf. force (provide breakable link for all cable pulling). There shall be no coils of excess cable left in the ceilings, cable trays, or raised floor areas unless specified otherwise. A trailer pull

string shall be left in all conduits before and after cables have been installed. The cabling within the wiring closets/cabinets shall be routed and dressed neatly to their termination points such that no excess cable is present. As cables are pulled into the cabinet, bundle them in groups with Velcro type straps according to their terminating row position. Strap exposed cables for strain relief at the termination in the communications rooms.

4. All strapping and lashing of cable within the TR(s) and ITR(s) shall be made with "Velcro" type straps for easy access to cable bundles to facilitate future "adds and changes". No plastic tie-wraps will be allowed for support of cable.
5. All cabling will be rated for a minimum operation range of -20°C to 75°C
6. All floor and wall penetrations shall be fire-stopped in accordance with local codes and restrictions.
7. New cabling will be installed in cable tray, conduit, and/or J-hooks throughout entirety of cable path.

B. Horizontal Cable

1. Install voice and data cable locations and configurations as depicted on drawings.
2. Test all cable prior to installation. Upon failure to perform testing, the installer shall accept the cable as good and assume all liability for the replacement of the cable should it be found defective at a later date.
3. All conformance standards must be certified for multipair and individual cable runs.
4. Jacketing and insulation must satisfy the Underwriter's Laboratories (UL) listed fire rated cable insulation requirements in plenum areas.
5. Any pulling compound or lubricant used in cable installation must not deteriorate the conductor or the insulation. Provide 3M type WLC or an approved equal.
6. Copper cable runs shall not exceed 295 feet. All runs shall be continuous. No splicing is allowed.
7. The Contractor shall install copper cable with a minimum bend radius of six times the diameter of the cable.
8. Provide a 10-foot, patch cable with RJ-45 connectors for 50% of each work area outlet insert installed. Provide a combination of 5, 7 and 10-foot patch cords for each termination in the TR rooms, as required on the contract drawings. The patch cable rating and connector shall match the horizontal cable/connector rating.
9. Install 10-feet of spare copper cable (service loop) in each closet prior to termination. Provide Velcro type tie wrap for cable support and organization.
10. Install minimum 12-inches of spare copper cable in ceiling plenum prior to dropping down wall to outlet. Support slack to structure with J-Hook and Velcro ties. If there is no plenum, loop shall be located in box prior to termination. Provide box of sufficient size to accommodate spare cable, termination equipment if applicable and maintain bending radius.
11. Install 10-feet of spare copper cable (service loop) at each above ceiling outlet prior to termination. Provide Velcro type tie wrap for cable support and organization.
12. All horizontal cable shall be rated for plenum use.
13. The maximum pulling tension for 4-pair 23 AWG horizontal UTP cables shall not exceed 32 lbf. The Contractor shall provide a tension meter during the pulling of all cables. If the meter shows that the tension has exceeded 32 lbf, the Contractor shall discard the cable and pull new cable.

3.3 WORKSTATION TERMINATION

A. At the workstation termination point, cables shall be routed and dressed to provide a service loop in case re-termination is necessary. Leave 12 inches of slack at the junction box. Provide strapping of voice and data cable to provide strain relief of cable in relation to outlet termination.

B. Each horizontal workstation cable shall terminate on a modular jack connector and attached to the outlet faceplate. All unused faceplate ports will have a blank insert.

C. The Contractor shall adhere to the latest termination procedures as specified by manufacturer's instructions.

D. Follow TIA/EIA 568-B termination procedures.

3.4 PATCH SYSTEM

A. Each horizontal data cable will terminate on an IDC based patch panel. Horizontal termination of individual data cables within the communications room shall be the same as aforementioned termination procedures for the workstation cables.

B. Mount the distribution panels starting at the upper most position of the racks/rails beginning with contractor provided fiber patch panels. Allow for sufficient space between the distribution panels to allow

for horizontal wire managers and cross connect component installation. Provide a detail of your elevation plan to the OWNER or Owner's Representative before proceeding.

C. Provide and install Category 6/6A patch cables (as described in parts list) for channel testing. Three/five/seven/ten foot cables for IT space patching.

D. Small diameter patch cords, which are installed in the IT spaces (Telecommunications Rooms) shall installed in a manner as to limit the bundling of patch cords to no more than 40 patch cords.

3.5 TESTING

A. Copper Media Testing:
   1. Contractor shall utilize personnel trained in the operation of the following Level II rated test equipment:
      a. Fluke DSX Series
      b. Ideal LanTEK III
      c. Or approved equal
   2. All cables and termination hardware shall be 100% tested for defects in installation and to verify cable channel performance under installed conditions. The Contractor prior to system acceptance shall verify all conductors of each cable useable. Any defect in the cable system installation including but not limited to cable, connectors, patch panels and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
   3. Perform end to end link testing of all cabling and connections with specified equipment and certify as meeting the criteria as defined in Category 6 UTP cabling systems within the most current publication of TIA/EIA 568-C.
   4. Provide equipment calibration reports with test results.
   5. Provide 72 hours notice to the OAR prior to testing.

3.6 CLEANING

A. Upon completion of the installation, make all components free of any oil, grease, dust and debris.

B. Work areas will be cleaned at the end of each work day and a final cleanup will occur at project completion.

3.7 DOCUMENTATION

A. Electronic submittal, via CD ROM, of required cable test results, As-Built drawings, and warranty information will be submitted to the Owner or Owner's representative at least ten (10) working days before Certificate of Occupancy is awarded. CAD files shall be submitted in AutoCAD (.dwg) format. When proprietary software is needed to view cable test results, the contractor will provide a licensed copy for Eagle Mountain Saginaw ISD IT Department.

3.8 ACCEPTANCE

A. Review test results and conduct a final inspection and punch list walk-thru with Owner and/or OAR, to inspect installation and obtain concurrence. Concurrence does not waive the responsibility of the Contractor to correct deficiencies.

END OF SECTION

SECTION 27 21 00

DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes specifications for the active network switching equipment and integration services required to support the Eagle Mountain-Saginaw Central Administration Project.
   1. Contractor is responsible for providing a minimum one (1) year of extended support for all network equipment, starting from the date of acceptance by the owner.

C. This section is accompanied by a drawing set which details quantities, installation details and locations, rack elevations, and cable routing.

D. All equipment shall be purchased under the Eagle Mountain-Saginaw name for warranty and O&M purposes.

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:

1.	EIA	Electronics Industries Association
2.	GbE	Gigabit Ethernet
3.	GBIC	Gigabit Interface Converter
4.	Gbps	Gigabit per second
5.	IDF	Intermediate Distribution Frame
6.	IEEE	Institute of Electrical and Electronics Engineers
7.	MDF	Main Distribution Frame
8.	PoE	Power over Ethernet
9.	RFP	Request for Proposal
10.	SCS	Structured Cabling System
11.	STD	Standard
12.	TIA	Telecommunications Industry Association
13.	UL	Underwriters Laboratories
14.	UTP	Unshielded Twisted Pair

1.3 QUALITY ASSURANCE

A. All equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the Owner.

C. Strictly adhere to all TIA, BICSI, and the manufacturers recommended installation practices when installing network equipment.

D. Contractor’s Qualifications:
   1. Firms regularly engaged in the installation of Data Communications Equipment and that have five (5) years of installation experience with systems similar to that required for this project.
   2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked, and the clients will be asked questions relative to the performance of your company.
   3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.

4. Provide a Hewlett Packard certified professional for oversight on this project. This person does not have to be working on-site but must be accessible to answer questions and provide weekly status reports. The professional shall be a full-time employee of the contractor.
5. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the Owner.

E. Manufacturer's Qualifications:
1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

F. Material and Work specified herein shall comply with the applicable requirements of:
1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2015
2. ANSI/TIA-568.0-D-1 –Generic Telecommunications Cabling for Customer Premises – Addendum 1, Updated References, Accommodation of New Media Types, 2017
3. TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard, 2009 - Part 1: General Requirements, 2009
4. TIA-568-C.2 – Commercial Building Telecommunications Cabling Standard, 2009 - Part 2: Balanced Twisted Pair Cabling Components, 2009
5. TIA-568-C.2-1 - Balanced Twisted Pair Cabling Components, Addendum 1: Specifications for 100 Next Generation Cabling, 2016
6. TIA-568-C.2-1 - Balanced Twisted Pair Telecommunications Cabling and Components, Addendum 2: Additional Considerations for Category 6A Patch Cord Testing
7. ANSI/TIA-606-C – Administration Standard for Telecommunications Infrastructure, 2017
8. TIA-607-C – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, 2015
9. ANSI/TIA-942 – Telecommunications Infrastructure Standard for Data Centers, 2006
10. NFPA 70 – National Electrical Code, 2017
11. UL 13 – Standard for Safety for Power-Limited Circuit Cables
12. UL 444 – Standard for Safety for Communications Cables
13. IEEE 802 – Local Area Network Standard
14. Applicable codes and directives of authorities having jurisdiction

G. Work:
1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.

H. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the Owner in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by Owner, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The Owner must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the Owner in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 270500.

C. Produce Shop Drawings showing the installation locations of all network gear, including rack elevations, one-line diagrams showing network connectivity and the fiber assigned to network equipment.

D. Provide all submittal requirements under this section as a single package.

E. Provide product data for the following:
   1. Product data consisting of manufacturers specifications for each type of product to be installed, all applicable certifications and elevation/plan documents supporting compliance with stated Specifications.
   2. Manufacturer’s certificate of acceptance of the qualifications of the installing Contractor to install, test and maintain the manufacturer’s equipment.
   3. Proposed format of as-built documentation.

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (4) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. As-built equipment schedules with makes, models, serial numbers, MAC addresses and asset tags.
   3. As built documentation of all fiber assignments.
   4. As built documentation of MDF/IDF modifications and associated cabinet elevations.

B. Warranty and Maintenance:
   1. Documentation shipped with equipment.
   2. Record Drawings

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer’s recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the Owner.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics, following Contractor Warranty requirements defined in Division 01. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

PART 2 – PRODUCTS

2.1 GENERAL

A. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

2.2 NETWORK SWITCHES

A. Hewlett Packard Enterprise Switches –
   1. HPE Aruba 8320 L-3 Managed
      a. JL479A#ABA — HPE Aruba 8320
      b. J9283D — Direct attach copper cable 10GBase
      c. H8XQ2E — 5-year extended service
      d. J9150D — Transceiver Module/LC MM
      e. JP151E — Transceiver Module/LC SM
      f. J8177D — Transceiver Module/Cat 5e RJ-45
      g. JH234A — Direct attach cable
   2. HPE Aruba 5412R ZL2 Managed
      a. J9822A — Aruba 5412R Bundle
      b. H1NB4E — 3-year extended service
      c. J9830B#ABA — 2750W Power Supply
      d. J9990A — Expansion Module (POE+) x20+gigabit Ethernet
      e. J9986A — Expansion Module (POE+) x24
      f. J9995A — Expansion Module (POE+) x8
      g. J9827A — Management Module Network management device- Plug in module
   3. HPE Aruba 5406R ZL2 Managed PoE+
      a. H1MS3E — 3-year extended service
      b. J9828A#ABA — Power supply 700-Watt Plug in Module
      c. J9996A — Expansion Module 40 Gig QSFP+ x 2

B. General:
   1. Contractor shall confirm exact make, model, configuration and accessories with EMSDISD IT prior to placing order.
   2. Contractor shall request and utilize EMSDISD IT approved reseller for procurement.
   3. Contractor shall provide and install network switches for a complete operational system.

2.3 WIRELESS NETWORK EQUIPMENT

A. Indoor Wireless Access Points
   1. Provide indoor wireless access points for the EMSISD WLAN system.
   2. Access point shall comply with IEEE WLAN Standards:
      a. IEEE 802.11a
      b. IEEE 802.11ac Wave 2
         1) 8x8:8 MU-MIMO 802.11ac beamforming
         2) 20- and 40-MHz channels
      c. IEEE 802.11b
      d. IEEE 802.11g
      e. IEEE 802.11h
      f. IEEE 802.11n
   3. Access point shall support the following security standards:
      a. 802.11i, Wi-Fi Protected Access 2 (WPA2), WPA
      b. 802.1x
   4. Access point shall be capable of operating in the 2.4 GHz and 5 GHz bands.
   5. Access point shall be powered using Power over Ethernet.
   6. Access point shall accept external antennas and be able to operate in temperature ranges of 32 degrees to +104 degrees Fahrenheit.
   7. Access point shall be suitable for use in plenum spaces in compliance with UL 2043.
   8. Include five year Cisco Meraki Enterprise cloud controller subscription license.
   9. Acceptable products:
      a. Cisco
         1) Cisco Meraki MR55 Dual Band DC Power
         2) 1-Year Smart Net 8x5xNBD, starting from the date of acceptance by the Owner.
      b. Outdoor enclosures
         1) Contractor to provide outdoor rated enclosure only when the Wireless access point is located in a wet location as defined by the NEC.
         2) Oberon 1024-C NEMA 4 with hinged clear door.
      c. Provide all parts for a complete installation.
      d. Owner Approved Equivalent.
   10. Contractor shall confirm exact make, model, configuration and accessories with EMSISD IT prior to placing order.
   11. Contractor shall request and utilize EMSISD IT approved reseller for procurement.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify rack grounding and bonding following Section 270526.

B. Verify the appropriate power circuit voltage, amperage and plug types were provided by the Division 26 contractor and the appropriate power distribution has been provided per Section 271100.

C. Verify the equipment cabinets include the appropriate air circulation baffles, following Section 271100.

3.2 CONFIGURATION

A. Turn over the network electronics to the Owner for configuration and asset tagging. The Owner will configure, and the contractor will assist the owner with the installation of the network electronics.

3.3 PREPARATION

A. Verify that the space is free of dust and debris, and will continue to be free of dust and debris, and that the HVAC filters have been properly cleaned, or replaced.
B. Ensure the room and equipment cabinet can be properly secured after installation.
C. Maintain temperature of between 65 degrees Fahrenheit and 78 degrees Fahrenheit and between 30 and 50 percent humidity in areas of voice and data system work.

3.4 INSTALLATION

A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data will be included on the drawings.

B. The Contractor will adhere to the installation schedule of the General Contractor and should attend all construction meetings scheduled by the General Contractor.

C. The installation will include coordination, testing and problem resolution with the system vendors.

D. The contractor will be responsible for making all necessary fiber optic and copper cross connects.
1. Fiber optic patch cords are provided under Section 271300.
2. Copper patch cords are provided under Section 271500.
3. Redundant fiber optic backbone connections shall be made to each switch.
4. The backbone connections shall utilize diverse paths back to the distribution layer switches.

E. The Owner requires a system inspection prior to the powering up of any hardware.

END OF SECTION

SECTION 27 41 00

AUDIO VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section contains the Audio Video (AV) System technical specifications. The associated Drawing Set, including the General Notes, further specifies the system and is part of the technical specifications.

C. The Audio Video Systems may include, but are not limited to, the following types of devices:
1. Light Emitting Diode (LED) Liquid Crystal Displays (LCD) Monitors
2. Display Mounting Hardware
3. AV Equipment Racks and Accessories
4. AV System Switchers
5. Video Processors
6. Audio Processors and Amplifiers
7. Audio Speakers
8. Microphones
9. Cameras
10. Control Processors and Control Interfaces
11. Signal Extenders and Accessories

D. The Contractor shall integrate the AV System with other building systems. Integration shall include software and hardware components as described below and in this section.
1. Local Area Network (LAN) for AV Control: The Contractor shall connect and program AV control devices operating on the LAN. The Contractor shall coordinate all network requirements with the Owner's Representative prior to implementation.
2. Mounting: The Contractor shall coordinate the mounting location of AV devices with other building trades. Coordination shall include the mounting location of the device, mounting hardware, back boxes, and other nearby equipment.
    a. Where input panels are flush mounted in work surfaces, coordinate the location and mounting with other AV devices, voice/data outlets, electrical receptacles, and furniture or millwork. Refer to device specifications for additional mounting requirements.
    b. Where display devices are mounted, coordinate the location of AV back boxes, voice/data outlets, and electrical receptacles, with the exact mounting hardware to be installed, and provide clear access to cables and connectors.
    c. Where touch screens are surface mounted, coordinate location of cable routing with other AV devices, voice/data outlets, electrical receptacles, and furniture or millwork. Provide grommets as necessary for cable routing. Refer to device specifications for additional mounting requirements.

1.2 PROFESSIONAL REFERENCES

A. Comply with provisions of Division 01.

1.3 RELATED SECTIONS

A. Refer to Section 27 05 00.

1.4 SCOPE OF WORK

A. The Contractor shall provide AV Systems as detailed on the drawings and the project specifications, inclusive of the input source devices, signal transportation infrastructure, switching and scaling devices, signaling and control devices, output display devices, cabling, and all associated accessories required for a complete and working system.

B. The Contractor shall provide all equipment, material, software, labor and services required to construct and install the AV Systems based on these specifications and design drawings including, but not limited to:

1. Submittals, as specified herein, including but not limited to shop drawings which expand upon the design drawings
2. Equipment, materials, software, labor and services not specifically mentioned or shown, which may be necessary for the installation and full operation of the AV system.
3. Hardware as specified for the system, including any required for a complete and working system which may not be listed
4. Installation and setup of the system hardware and software including all programming.
5. Software specified or required to make the system fully operational, including the provision of IP addresses and firewall provisions.
6. Final connection of hardware to power, infrastructure termination, and patch cords connecting system equipment to the data outlets and other network communication equipment.
7. As-Built documentation for all AV hardware and software components as specified herein.
8. Asset tagging and completion of inventory control sheet, as specified herein.
9. Test plans, system testing, and commissioning as specified herein.
10. System warranty as specified herein.
11. Training as specified herein.
12. Maintenance and support as specified herein.

C. Contractor shall provide the following systems:
   1. IPTV and Digital Signage (Refer to “Add-Alternate Pricing” included herein)
   2. Room Scheduling System
   3. Discovery Labs
      a. The discovery labs are classrooms which shall receive multiple interactive monitors. The Android-based PC shall be rack mounted for each monitor, with HDMI and USB from each source routed through a matrix switcher to allow any content to be shared to any interactive monitor.
      b. Interactive monitors shall include a contractor-furnished cart, where indicated in the drawing set.
      c. Interactive monitors shall include a teleconference soundbar with integrated microphone, where indicated in the drawing set.
      d. USB extensions shall be provided by contractor as necessary (USB matrix switcher to monitors, teleconference soundbars to USB matrix switcher).
      e. HDMI extensions shall be provided by contractor as necessary (HDMI matrix switcher to monitors, HDMI input plates to HDMI matrix switcher).
      f. A touchpanel control interface shall be provided to allow control of the system (power, signal routing).
      g. Equipment shall be rack-mounted in the nearest MDF/IDF as indicated in the drawing set.
   4. Boardroom
      a. The boardroom is a divisible room, which functions as a training room when not used as a boardroom. The system shall include a partition sensor for automation of the AV system between these two conditions.
      b. The boardroom system shall consist of a chassis-based digital video matrix switcher, audio digital signal processing, audio amplifier(s), video conferencing cameras and accessories, wired and wireless microphones, assistive listening, two hardware encoders, contractor-furnished PC with post-production software, wireless presentation, and a control processor with tabletop touchpanel interfaces.
      c. The boardroom shall also include an AV cabinet with covers, ventilation, blank panels, power distribution, and accessories as shown in the drawings and required in these specifications.
      d. The boardroom shall include large format monitors for the audience, and smaller desktop monitors for the board members, control room, and back-of-house table located at the back of the room.
         1) All smaller desktop monitors at the dais and nearby tables (total of approximately 16) shall receive the same cloned video content from the Boardroom AV system, by placing HDMI distribution amplifiers within the millwork.
         2) The large format monitors for the audience shall each be connected directly to the matrix switcher, allowing the same or different content on each monitor.
      e. The boardroom touchpanel control interface shall also control the power status and video routing to the adjacent lobby videowall. The content player for the videowall shall be housed in the boardroom AV cabinet, with an HDMI extension to the lobby videowall.
      f. The boardroom shall include pendant speakers installed above the wooden slat ceiling and recessed ceiling speakers installed in the gyp ceilings. Speakers shall be zoned as shown in the drawings for a mix-minus application to reduce potential microphone feedback at the dais.
      g. The boardroom shall include HDMI inputs and HDMI outputs as indicated in the drawing set.
      h. The boardroom shall include audio outputs at the back of the room, for connection to Media broadcasting equipment (Media equipment provided by others).
   5. Training Rooms
      a. There are two (2) training rooms, one which is divisible and one which is not divisible. Both rooms are otherwise comparable in AV equipment, form and function.

b. The training rooms' systems shall consist of a digital video matrix switcher, audio digital signal processing, audio amplifier(s), wireless microphones, assistive listening, wireless presentation, and a control processor with wall-mounted touchpanel interfaces. Some of this equipment may be offered by the manufacturer combined into a single enclosure (such as matrix switcher and control processor).
c. The training rooms shall also include an AV rack or cabinet as shown in the drawing set. The rack or cabinet shall include, as necessary, covers, ventilation, blank panels, power distribution, and accessories as shown in the drawings and required in these specifications.
d. The training rooms shall include large format videowall monitor arrays for the audience as shown in the drawing set.
e. The training rooms shall include ceiling speakers, zoned for divisible room application where indicated in the drawing set.

6. Small (Typically 4-Chair) Conference Rooms
   a. There are a number of small conference rooms, where the conference table is pushed against the wall below the monitor. These rooms often have 4 chairs at the table. There are a couple instances of larger tables with more than 4 chairs which are also pushed against the wall under the monitor; these rooms will receive the same solution as the 4-chair conference rooms.
   b. Provide equipment as indicated in the drawing set.
   c. An HDMI cable shall be left neatly hanging from the monitor, coiled on the conference table below.
7. Conference Rooms and Workroom
   a. Provide equipment as indicated in the drawing set, including monitors, microphones, videoconferencing cameras, and tabletop touchpanel control interfaces.
   b. Microphones may be integrated within the soundbar except where the furthest talker exceeds the manufacturer's recommended distance (15-feet) in which case ceiling microphones shall be provided separately with a soundbar.
   c. The conference room tabletop enclosures shall be provided with the table. The AV integrator shall coordinate with the table vendor to ensure that the ports provided with the table meet the AV infrastructure requirements.
   d. Rooms with modular tables (i.e. Workroom) will receive the AV input connections in the floorbox in lieu of tabletop.
8. Safety and Security Office
   a. Provide equipment as indicated in the drawing set.
   b. The owner shall furnish small form-factor PCs with CCTV client software for viewing of CCTV camera feeds, which the contractor shall install behind the monitors.
   c. The contractor shall provide an IP-based KVM system for each computer, to allow remote access and control from any workstation in the Safety and Security Office.
9. Lobbies
   a. Contractor shall provide displays and IPTV / digital signage players as indicated in the drawing set.
10. Miscellaneous Monitor Locations
    a. Contractor shall provide monitors and accessories at miscellaneous locations (corridors, private offices, dining, etc) as indicated in the drawing set.

1.5 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:

1.	AFF	Above Finished Floor
2.	AHJ	Authority Having Jurisdiction
3.	AWG	American Wire Gauge
4.	AVIXA	Audiovisual and Integrated Experience Association
5.	BICSI	Building Industry Consulting Service International
6.	CMR	Communications Riser Cable
7.	CMP	Communications Plenum Cable
8.	CTS	Certified Technology Specialist
9.	DSP	Digital Signal Processor
10.	EDID	Extended Display Identification Data
11.	EMI	Electromagnetic Interference
12.	HD	High Definition
13.	HDCP	High-bandwidth Digital Content Protection
14.	HDMI	High-Definition Multimedia Interface
15.	Gbps	Gigabits per second
16.	IEEE	Institute of Electrical and Electronics Engineers
17.	IP	Internet Protocol
18.	ISO	International Standards Organization

19. KVM — Keyboard / Video / Mouse
20. LAN — Local Area Network
21. LCD — Liquid Crystal Display
22. LED — Light-Emitting Diode
23. OLED — Organic Light-Emitting Diode
24. NECA — National Electrical Contractors Association
25. NEMA — National Electric Manufacturers Association
26. RFP — Request for Proposal
27. SPL — Sound Pressure Level
28. STD — Standard
29. UL — Underwriters Laboratories
30. UTP — Unshielded Twisted Pair
31. VESA — Video Electronics Standards Association

1.6 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturer
      a. Equipment and materials shall be a standard product of manufacturers regularly engaged in the manufacture and installation of that type of equipment for a minimum of (5) years.
      b. The equipment and materials shall be the manufacturer's latest standard design.
      c. Items of the same classification shall be by the same manufacturer and shall be the same series and model. This requirement includes equipment, modules, assemblies, parts, and components.
   2. Supplier
      a. Equipment and materials shall be a standard product of suppliers regularly engaged in the supply of that type of equipment and shall be the manufacturer's latest standard design.
      b. Items of the same classification shall be supplied by the same manufacturer. This requirement includes equipment, modules, assemblies, parts, and components.
   3. Contractor
      a. The Contractor must have been in the business of selling and installing similar systems for a minimum of three (3) years.
      b. The Contractor shall have been actively engaged in installing, maintaining and operating similar systems and services as outlined in the Specifications.
      c. The Contractor shall have a minimum of three (3) sites that are actively using the same system with the same version of the software, and each of those sites must be currently in operation and have been in operation for at least the proceeding twelve (12) months.
      d. The Contractor shall submit a minimum of three (3) reference sites, to include client names, phone numbers, and a summary of work, that are actively using the system proposed by Contractor. These references will be checked, and the clients will be asked questions relative to the performance of your company.
      e. Provide an AVIXA CTS certified professional for oversight on this project. This person does not have to be working on-site but must be accessible to answer questions and provide weekly status reports. The CTS shall be a full-time employee of the Contractor.
      f. Provide full time project manager with a minimum of ten (10) years field experience in installation of audiovisual systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the Owner.
   4. Installers
      a. All lead technicians performing installation shall have a minimum of two (2) years of experience on the proposed system and be manufacturer certified on all hardware/software applications.
   5. Material and Work specified herein shall comply with the applicable requirements of:
      a. NECA 1 – Standard for Good Workmanship in Electrical Construction, 2015
      b. ANSI/TIA-568.0-D-1 – Generic Telecommunications Cabling for Customer Premises – Addendum 1, 2017
      c. ANSI/TIA-568.1-D – Commercial Building Telecommunications Infrastructure Standard, 2015
      d. ANSI/TIA-568.1-D-1 – Commercial Building Telecommunications Infrastructure Standard – Addendum 1: Updated References, Accommodation of New Media Types, 2018
      e. ANSI/TIA-606-C – Administration Standard for Telecommunications Infrastructure, 2017
      f. ANSI/TIA-607-C – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, 2015
      g. NFPA 70 – National Electrical Code, 2017
      h. UL 13 – Standard for Safety for Power-Limited Circuit Cables
      i. UL 444 – Standard for Safety for Communications Cables
      j. UL 497B – Standard for Protectors for Data Communications and Fire-Alarm Circuits
      k. IEEE 802 – Local Area Network Standard
      l. Title 47 CFR Part 15 – Radio Frequency Devices

m. BICSI – Telecommunications Distribution Methods Manual, 13th Edition
n. ANSI/AVIXA-V202.01:2016 - Display Image Size for 2D Content in AV Systems
o. ANSI/AVIXA-F501.01:2015 - Cable Labeling for AV Systems
p. ANSI/AVIXA-A102.01:2017 - Audio Coverage Uniformity in Listener Area
q. ANSI/INFOCOMM-2M-2010 - Standard Guide for AV System Design and Coordination Processes
r. ANSI/INFOCOMM-3M-2011 - Projected Image System Contrast Ratio
s. ANSI/INFOCOMM-4:2012 - Audiovisual Systems Energy Management
t. ANSI/INFOCOMM-10:2013 - Audiovisual Systems Performance Verification
u. Applicable codes and directives of authorities having jurisdiction.

B. Certifications
1. UL Compliance and Labeling: Provide system components which are UL listed and labeled.

C. Work:
1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.7 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the Owner in writing prior to commencement of affected work.

1.8 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.9 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by Owner, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.10 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The Owner must approve material submittal and substitutions in writing prior to Contractor's ordering of material.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All materials proposed and provided by the Contractor must be new and unused. Materials refers to all hardware, software, equipment, cabling, accessories and incidentals.

D. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

E. The requirements as given in this document are to be adhered to unless revised by the Owner in writing.

F. The Owner reserves the right to waive these requirements at any time.

1.11 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. In addition to the requirements of Section 27 05 00, the Contractor shall provide the following shop drawings:
   1. Produce Shop Drawings for ALL audio-video systems. This shall include the following, such that any component, wire, or piece of equipment added to the system may be easily identified by going to the actual equipment and making reference to this information.
      a. Functional Block Diagram
         1) Provide overall block diagrams showing the major interconnections between components and subsystems. This should include cable type, connector type, and equipment locations, with components labeled as in the floorplans, wiring diagrams, elevation and arrangement drawings.
      b. Floor Plans
         1) Provide floor plans showing the location of all components in the system.
         2) Provide floor plan of any room housing AV cabinets, showing the location of each piece of related equipment in the room.
      c. Arrangement Drawings
         1) Provide Drawings showing the physical arrangement of all major system components. This includes, but not limited to, the proposed routing and its location relative to building structure (columns, floor or ceiling) and its relationship to electrical, mechanical elements.
         2) Drawings shall include projector throws to ensure there are no obstructions with lighting or other architectural features, as well as reflected ceiling plans for ceiling-mounted equipment.
         3) Coordinate the modification of cabinetry or tabletop modifications for review with the Owner. Provide plan and section drawings with equipment model numbers and cutout dimensions for proposed equipment mounting locations prior to work. Locations may include, but are not limited to, the following:
            a) Credenza Millwork
            b) Conference Tabletops
         4) Provide elevation drawings of all rack mounted and wall mounted equipment, showing the location of each component in the rack and on the wall. Components shown shall be identified as in the functional block diagrams.
      d. Wiring Diagrams
         1) Provide wire-by-wire diagrams showing all field installed interconnections. The wire color and identification on the diagrams shall agree with the wire and wire markers installed on the equipment.
      e. Control System Interface
         1) Provide images with brief narrative indicating the proposed touchscreen control interfaces' intended Graphical User Interface (GUI). The GUI shall be an intuitive custom interface that shall be designed in collaboration with the Owner and Owner's Representative. The Contractor shall conduct no less than two workshops (initial, finish/approval) with the Owner and submit shop drawings with operational narrative and/or flow diagram indicating the functionality for the Touchscreen GUI.

D. Provide product data for the following:
   1. Product data consisting of manufacturers specifications for each type of product to be installed, and all applicable manufacturer certifications supporting compliance with stated Specifications.
   2. Manufacturer's certificate of acceptance of the qualifications of the installing Contractor to install, test and maintain the manufacturer's equipment.
   3. Proposed format of as-built documentation

E. Provide complete product data submittal and shop drawing submittal packages simultaneously, as separate submittal packages.

1.12 INTELLECTUAL PROPERTY

A. Patents: Should patented articles, methods, materials apparatus, etc., be used in this Work, the Contractor shall acquire the right to use same. The Contractor shall hold the Owner and their agents harmless for any delay, action, suit, or cost growing out of the patent rights for any device on this Project.

B. Copyrights: Should copyrighted software be used in this Work, the Contractor shall acquire the right to use same. The Contractor shall hold the Owner and their agents harmless for any delay, action, suit, or cost growing out of the copyrights for any software on this Project.

C. License to Use: All software required for the complete operation of the system as specified herein shall be delivered with either full Ownership transferred to the Owner or a non-time limited License to use on each machine it is installed on, including the right to make backup copies.

D. Software Master Source Code: The Owner shall be provided with the master source code and configuration files for all system specific software. The intent is to provide everything required allowing the Owner to edit and re-configure the system with any changes.

1.13 MATERIAL PURCHASES

A. Latest Technology
   1. Products and materials shall be purchased by the Contractor in a timely manner to meet construction schedules but shall not be purchased so far advanced of the date(s) of installation that they become technologically obsolete or replaced with newer technologies.
   2. In the event the manufacturer(s) of submitted products and materials have upgraded or replaced their products and materials with newer or improved technologies at the time of purchase, the newer or improved products or materials shall be provided unless they are incompatible with the rest of system, or so directed by the Design Consultant.
   3. Latest technology products and materials shall be operationally and functionally equivalent or superior to the submitted products and materials. These products shall be submitted to the Design Consultant for approval, before ordering.

1.14 WARRANTY

A. Manufacturer Warranty: Provide the manufacturer's standard maintenance and support services for all hardware and software associated with this system at no additional charge for a period of not less than one (1) year. Replacement of equipment shall be included in the Contractor's System Warranty.

B. Contractor's System Warranty: The Contractor shall guarantee all labor, workmanship, and materials for a period of one (1) year from the date of Final Completion unless noted otherwise for specific systems. Should a failure occur within the Warranty period to the system, the Contractor shall provide all labor and materials necessary to restore the system to the condition required for the final test and Final Completion for this Contract, at no cost to the Owner.
   1. Emergency Warranty work shall include the repair or replacement of components which fail during the warranty period excluding equipment damaged or rendered unserviceable due to apparent and provable misuse, abuse, vandalism or negligence by the Owner's employees or the public. Apparent and provable as used herein shall mean that the physical evidence indicates what and who caused the damage, e.g., lightning strike, liquid damage, someone other than the Contractor's technician, etc.
   2. Tie ins: During the Warranty period, additional components may be connected to the systems. New devices will be connected in the same manner as shown on the Drawings for this Contract and the existence of the new connections shall not void this Warranty guarantee.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Handle equipment and components carefully to avoid breakage, impact, denting and scoring finishes. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

B. Equipment delivered to the job site shall be opened and inspected immediately upon arriving and compared to the approved Shop Drawing submittal and checked for defects. If the equipment is not correct, the equipment shall be returned to the manufacturer immediately and a new order for the approved equipment shall be placed at no cost to the Owner.

C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to Final Completion shall be replaced at no cost to the Owner.

1.16 ADD-ALTERNATE PRICING

A. Contractor shall provide additional Add-Alternate prices for the following items:
   1. Extended Warranty and Maintenance Agreement
      a. Contractor shall include Add-Alternate pricing for the following options:
         1) 1-Year Extended warranty and Operations Maintenance Service Agreement
         2) 2-Year Extended warranty and Operations Maintenance Service Agreement
         3) 3-Year Extended warranty and Operations Maintenance Service Agreement
   2. IP Television / Digital Signage Platform
      a. Contractor shall include Add-Alternate pricing for an IP Television and Digital Signage solution, inclusive of the television encoding, content players, software, configuration, licensing, and installation.
      b. System shall support no less than 12 television channels and 4 digital signage channels.
      c. Basis of Design: Triple Play and BrightSign HD224 Players

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers for Audio Visual System Equipment and Cabling: Subject to compliance with requirements, manufacturers offering products are subject to approval by the Engineer.

B. Refer to Basis of Design for individual product examples to understand the Standard of Quality required. Any substitutions require approval in writing by the Owner's Authorized Representative.

2.2 GENERAL HARDWARE REQUIREMENTS

A. All hardware requirements given are the minimum requirements. Contractor's product shall meet or exceed these requirements. All devices shall be the manufacturer's latest model at the time of the equipment submittal. Additionally, the hardware selected shall meet the operational, functional, and performance requirements specified herein.

B. Approved Equal Substitution: The Contractor may propose an Owner Approved Equal device that meets or exceeds the specifications. Requests for hardware substitution shall be submitted in writing to the Design Consultant and Owner's Authorized Representative, and include the hardware cut sheet and the exact configuration being proposed, including any related input, output, control, and mounting equipment.

C. Environmental Rating: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. For devices located in harsh environments such as interior uncontrolled or exterior environments, the Contractor shall provide the necessary housings or enclosures to ensure proper equipment operation and performance. The equipment shall be designed for installation in the environment, based upon installation location:
   1. Interior controlled environment: 15 to 45 degrees C dry bulb and 20 to 80 percent relative humidity, non-condensing. Interior office areas shall be considered this type of environment.
   2. Exterior environments: -20 degrees to 70 degrees C dry bulb and 5 to 100 percent relative humidity, condensing.

D. Rack/Enclosure Accessories: Contractor is responsible for providing fans, shelves, drawers, special power wiring, ground connections, cables, connectors, appurtenances, and adapters of any kind necessary to accommodate the system installation, operation, testing, or maintenance. This includes those accessories required for a clean and organized installation.

2.3 AV SYSTEM ARCHITECTURE

A. The Audio Video Systems shall be integrated systems comprised of video, audio, and control equipment. The input, routing, processing, distribution, output and control of the Audio Video Systems shall be seamless from the user's perspective.
   1. AV equipment shall be compliant with the transport of combined digital audio and video signals in the High-Definition Multimedia Interface (HDMI) format. HDMI components shall support minimum of 6.75 Gbps data rates, Deep Color up to 12-bit, and HD lossless audio formats.
      a. HDMI interfaces shall support the seamless application of the most current High-Bandwidth Digital Content Protection (HDCP) protocol.

   b. HDMI components shall manage VESA standard Extended Display Identification Data (EDID) communications to provide seamless routing and switching between sources and output devices.
2. Video: The input, routing, distribution, and output shall be at a minimum digital High Definition 1080p (1920x1080 pixels). Digital system sources may include input panels, computer workstations, media players and video conferencing. Outputs may include LCDs and/or projectors. Typical video transport methods utilized may include:
   a. HDMI transmission over twisted pair
3. Audio: Digital or analog input sources shall be processed using a digital signal processor with full software-based sound editing and mixing capabilities, routed to an amplifier, and distributed to speaker zones. Sound sources may include audio from input panels, computer workstations, media players and audio conferencing. Outputs shall include zoned speakers. Typical audio transport methods utilized may include:
   a. HDMI transmission over twisted pair
   b. Line level balanced mono audio
4. Control System: The control component of the AV Systems shall control the selection of video/audio routing. The user interface for the controls shall be touch screen or keypad controller. The AV Systems shall allow the user to select a source for display on the display(s), as well as control audio. Network communications shall utilize TCP/IP network protocol. Other common control methods which may be used include:
   a. Voltage relay contact closure
   b. Serial interface
   c. Infrared communications shall NOT be used unless approved in writing by the Owner's Authorized Representative

2.4 ROOM SCHEDULING

A. Scheduling Software
   1. Provide a room scheduling software platform to support the room scheduling touchpanels indicated in the drawing set.
   2. The system shall include:
      a. Ability to scale up to the entire district (multiple campuses) at a later date
      b. Compatibility with iPad hardware
      c. Integration options with Outlook, Office 365, and Google
      d. The ability to book a room ad-hoc, at the room's scheduling panel
      e. Dashboard management by floor, building, and campus
      f. Data export function for room utilization information
   3. The contractor shall include all programming, licensing, configuration, and integration required for a complete and working system.
   4. Basis of design: Teem Professional Room Booking

B. Room Scheduling Touchpanels
   1. Provide room scheduling touchpanels as indicated in the drawing set.
   2. The room scheduling panels shall feature:
      a. 7.9" Retina display with multitouch interface
      b. 2048x1536 resolution
      c. 500 nits brightness
      d. 802.11 a/b/g/n/ac Wi-Fi connectivity
      e. Lightning connector
      f. iPadOS
   3. The room scheduling panels shall include 64-Gb capacity, lighting to USB adapter, and USB power adapter.
   4. Basis of design: Apple iPad Mini (5th Generation)

C. Room Scheduling Mounts
   1. Provide mounting hardware for installation of room scheduling touchpanels.
   2. Contractor shall provide the proper mount based upon installation condition (gypsum wall versus window mullion).
   3. Mounting hardware shall include storage within for a POE adapter, to power the iPad.
   4. Mounting hardware shall maintain less than 4" clearance from the wall, as required by building code.
   5. Mount shall be compatible with the room scheduling touchpanels, specified herein.
   6. Basis of design: Heckler H500 and H565

2.5 LCD VIDEOWALL DISPLAYS

A. Narrow-Bezel Videowall Monitor (Type 3)
   1. Provide a 2x2 array (total of four monitors) using narrow bezel videowall monitors at the locations indicated in the drawing set.
   2. Displays shall be engineered and warranted for 24x7 operation.
   3. Displays shall feature:
      a. Loop-through daisy-chain functionality for 2x2 monitor arrays
      b. 1.7mm “bezel-to-bezel” width
      c. Ethernet and serial control
      d. HDMI and DisplayPort input
      e. 55” diagonal screen size
   4. Basis of design: Samsung UM55H-E

B. Videowall Monitor Mount
   1. Provide an LCD videowall monitor mount and hardware at the locations shown in the drawing set.
   2. Mounts shall feature:
      a. Mounts shall allow adjustment to height, depth, tilt, and lateral alignments
      b. Mounts shall allow display to extend minimum 12” for service
      c. Mount shall accept pad locks for added security
   3. Contractor shall ensure monitor edges are perfectly aligned upon installation completion.
   4. Contractor shall include edge cover accessory for a clean appearance.
   5. Basis of design: Chief LVS1U and CSACK06B

C. In-Wall Storage Enclosure
   1. Provide in-wall storage enclosures at all LCD videowall display locations, as shown in the drawing set.
   2. Enclosure shall feature:
      a. Adjustable depth for 2.5” or 3.5”” studs
      b. Knockouts for four (4) 1-gang recessed outlet boxes
      c. Knockouts for 1” and 1.25” conduits
      d. Trim flange and cover accessory included
      e. Cover shall include knockouts for cable routing and ventilation
   3. Basis of design: Chief PAC526FCW

2.6 LCD MONITORS AND ACCESSORIES

A. Recessed Outlet Enclosure
   1. Provide a recessed outlet enclosure at each television and digital signage monitor location, such as workrooms, lobbies, and office areas.
   2. Enclosure shall house a recessed electrical and data outlet, allowing the display to be mounted flush to the wall in a low-profile installation.
   3. Enclosure shall provide a single-gang receptacle for electrical, and a single-gang receptacle for communications.
   4. Basis of design: Hubbell NSAV62M, NSAV6C

B. In-Wall Storage Enclosure
   1. Provide in-wall storage enclosures at all interactive monitor locations, as shown in the drawing set.
   2. Enclosure shall feature:
      a. Adjustable depth for 2.5” or 3.5”” studs
      b. Knockouts for four (4) 1-gang recessed outlet boxes
      c. Knockouts for 1” and 1.25” conduits
      d. Trim flange and cover accessory included
      e. Cover shall include knockouts for cable routing and ventilation
   3. Basis of design: Chief PAC526FCW

C. Digital Signage / Television LCD Display (Type 2 in the Drawings)
   1. Provide a commercial-grade LED LCD display for each location shown in the drawing package.
   2. Display shall be sized as indicated in the drawings.
   3. Display shall include manufacturer’s 3-year warranty.
   4. At a minimum, display shall include:
      a. One (1) HDMI port
      b. One (1) Ethernet port
      c. One (1) RS-232 Serial Port
   5. Basis of design: LG Electronics UH5F-H Series

D. Display Landscape Mounting Bracket

1. Provide a landscape mounting bracket for digital signage and television installations.
2. Bracket shall be utilized for displays from 39-80” or 60”-98” depending upon application.
3. Basis of design: Peerless ST660 or ST680

E. Interactive Monitors (Type 1 in the Drawings)
1. Provide interactive monitors as indicated in the drawing set, sized 75” unless noted otherwise.
2. Interactive monitor shall include a fixed wall mount from the manufacturer with the display.
3. Contractor shall include any additional mounting hardware required.
4. Each monitor shall include:
   a. Up to 15 simultaneous touchpoints
   b. Android 8 operating system with easy access to Google Drive and OneDrive storage
   c. OPS Slot for expansion module accessories
   d. 75” 4K Resolution
   e. ActivConnect Collaboration Device
5. Basis of design: Promethean AP7-U75-NA-1 ActivPanel Nickel series, ACON1-OPS ActivConnect OPS-G Collaboration Device

F. Interactive Monitor Chromebox
1. Provide Chromebox computer in lieu of the standard OPS-G Android computer where indicated in the drawing set (i.e. Discovery Labs).
2. Contractor shall include a shelf accessory for mounting of the Chromebox computers in a rack.
3. Basis of design: Promethean Chromebox

G. Monitor Cart
1. Where indicated in the drawing set, provide a monitor cart.
2. Cart shall provide sturdy casters and locking guards for enhanced stability.
3. Cart shall include a shelf for storing devices.
4. Cart shall be compatible with any Promethean ActivPanel 65”, 70”, 75” and 86” display
5. Contractor shall include soundbar mounting accessory (Sanus SASB1 or equivalent) where soundbar is indicated in the drawing set.
6. Basis of design: Promethean ActivPanel Non-Adjustable Mobile Stand

2.7 AUDIO SYSTEMS

A. Standard Soundbar
1. Where soundbars are indicated in the drawing set to not require an integrated microphone, Contractor shall provide a Standard Soundbar.
2. Standard soundbar shall feature:
   a. Dual Channel 20-Watt RMS
   b. Two 3” and Two 1” Speakers per Channel
   c. 50-Hz – 20-KHz Frequency Response
   d. Native compatibility with the Promethean ActivPanel displays
3. Basis of design: Promethean ActivSoundBar

B. Smart Soundbar
1. Where soundbars are indicated in the drawing set to require an integrated microphone, Contractor shall provide a Smart Soundbar.
2. Smart Soundbar shall feature:
   a. USB interface
   b. Pair of High-Performance Speakers
   c. Adaptive beamforming microphone array
   d. Minimum 15-foot microphone pick up range
   e. 180-degree microphone pick up angle
   f. Acoustic echo cancellation, ambient noise cancellation
   g. Black or white finish, coordinate color with architect via submittal process
3. Basis of design: TOA AM-CF1

C. Ceiling Microphones
1. Provide ceiling microphones as indicated in the drawing set.
2. Ceiling microphones shall feature:
   a. Green/Red LED Mute Indicator Light
   b. Low-profile ceiling mount design (.75” high)
   c. Beamtracking technology, with four 90-degree zones for full 360-degree coverage
   d. Only one AEC channel required per microphone

e. Network audio using AVB protocol
f. Plenum network box above ceiling supports up to (2) ceiling microphones
g. Provide black and white finishes based upon the ceiling condition, as indicated in the drawing set.

3. Basis of design: Biamp TCM-X (primary Type-A mic) and TCM-XEX (secondary Type-B mic)

D. Audio DSP
1. Provide audio Digital Signal Processors (DSP) as indicated in the drawing set.
   a. Contractor shall provide appropriate DSP based upon the required number of AEC channels and the available analog input/output capacity.
2. Audio DSPs shall feature:
   a. Minimum of 4 input and 4 output
   b. Minimum of one AEC Channel per Microphone
   c. 128 x 128 AVB network audio interface
   d. Voice Over IP (SIP) telephone interface
   e. Network & Serial control interfaces
   f. USB DSP Expansion Modules, where required
   g. Five (5) year manufacturer warranty
3. Basis of design: TesiraFORTE AVB VT and TesiraFORTE AVB VT4, Tesira EX-UBT

E. Audio Amplification
1. In instances where the integrated amplifier in the Presentation Switcher does not provide sufficient power, provide and install a Class D audio amplifier to power 70V speakers.
2. Amplifier output power shall be at least 30% greater than the speaker power draw.
3. High-Quality Sound Reproduction: The system shall provide clean audio, free from noises such as pops, clicks, hiss/hum and access/disconnect tones at all loudspeakers at all times during operation including standby mode.
4. Performance Criteria: Coverage of amplified sound shall be within the following specified limits. Sound levels (20Hz – 20KHz) shall be 10 – 12dB over ambient and shall not vary more than 3dB throughout a zone.
5. 70-Volt Amplifier: Internal transformers for 70V distribution to speakers. Amplifiers to include the following: minimum of a single channel with no less than 200 watts. Shall include complete self re-setting protection against short circuit, improper load, and over temperature conditions. Input level controls shall be provided. THD+N shall be less than 0.1%. S/N ratio shall be greater than 100 dBA.
6. Input: balanced mono, 3.5 mm captive screw
7. Output: 70-volt mono, 5 mm captive screw
8. Power: 120V, 60Hz
9. Mounting: Rack mounted using rack-mount accessories
10. Control: Remote Volume and Mute Controls
11. Basis of Design: Extron XTRA Series XPA Amplifier

F. Recessed Ceiling Speakers
1. Provide and install UL-listed two-way loudspeakers as shown in the drawing package for Local Audio-Video systems.
2. The speakers should be tapped according to the quantity of speakers and SPL requirements.
3. 6.5” long-throw woofer
4. .75” ferrofluid-cooled dome tweeter
5. Sensitivity: 88 dB SPL 1W at 1m
6. Frequency Response: 88Hz to 22kHz
7. Dispersion: 111 degrees (1kHz to 4kHz)
8. Rated Power: 130 watts RMS (continuous program)
9. Transformer:
   a. Primary Voltage: 70.7V
   b. Primary taps at: 64W, 32W, 16W, 8W, and 8-Ohm Direct
10. Overall Assembly Diameter: 10.64”
11. Enclosure:
    a. Enclosure shall be designed and manufactured specifically for the driver.
    b. Front-loading driver design with tuned ported housing.
12. Grille: Round magnetically-secured thin-edged bezel. Provide standard white finish.
13. Basis of Design: Extron SF26CT

G. Pendant Ceiling Speakers
1. Provide and install two-way pendant loudspeakers as shown in the drawing package for Local Audio-Video systems.
2. The speakers should be tapped according to the quantity of speakers and SPL requirements.

3. 6.5” long-throw woofer
4. .75” ferrofluid-cooled dome tweeter
5. Sensitivity: 86 dB SPL 1W at 1m
6. Frequency Response: 70Hz to 20kHz
7. Dispersion: 95 degrees (1kHz to 4kHz)
8. Rated Power: 130 watts RMS (continuous program)
9. Transformer:
    a. Primary Voltage: 70.7V
    b. Primary taps at: 64W, 32W, 16W, 8W, and 8-Ohm Direct
10. Overall Assembly Diameter: 9.0”
11. Finish: White or black, coordinate color with architect via submittal process.
12. Basis of Design: Extron SF26PT

H. Gooseneck Microphones
1. Provide gooseneck microphones at the locations indicated in the drawing set.
2. Microphones shall include:
    a. RF interference rejection
    b. 18-inch adjustable gooseneck
    c. Mute button with LED indicator
    d. Interchangeable cardioid cartridge
    e. Shockmount assembly
3. Coordinate exact placement within the millwork with the architect prior to installation.
4. Basis of design: Shure MXA418S/C

I. Wireless Microphone System
1. Provide wireless microphone kits as shown in the drawing set.
2. Each training room and board room shall receive two lavalier and two handheld microphones for simultaneous use, or quantity as indicated in the drawing set (whichever is greater).
3. If the microphone receivers are not in the same room as the wireless microphones, the antennas shall be extended into the room as shown in the drawing package. A passive antenna combiner kit with 50-ohm coaxial cable, BNC connectors, and stainless-steel antenna wallplates shall be utilized such that all receivers can utilize 2 antennas.
4. Basis of design: Shure QLX-D Series Wireless System, UA845UWB, 50-Ohm Plenum Coax

J. Assistive Listening System
1. The Contractor shall furnish and install a rack-mounted assistive listening system where indicated.
2. The system shall utilize RF signal distribution, and shall include the appropriate number of receivers, earphones, neckloops, signage and accessories as required by Code based upon the maximum occupancy.
3. The assistive listening system shall utilize an antenna extended to the relevant area.
4. Approved products:
    a. Williams Sound AV FM 558 PRO D System
    b. Owner-Approved Equivalent

2.8 CONTROL SYSTEMS

A. Control Processor
1. Contractor shall provide control processors, as indicated in the drawing set.
2. It is acceptable for the control processor to be integrated within a Presentation Switcher, if the room’s AV system includes a Presentation Switcher that would allow such efficiency.
3. Control processor shall feature:
    a. Two Bi-directional RS232 serial control ports
    b. Ethernet control interface
4. Basis of design: Extron IPCP Pro Series

B. Touchscreen AV Controller
1. Provide and install a color touch panel as shown in the drawing package.
2. The design of the color touch panel “pages” and menu system shall be coordinated with and approved by the Owner. The Contractor shall include cost to create unique touch panel pages.
3. The units shall offer two-way operation to allow for visual control feedback of system status. The units shall be provided with sufficient internal memory and light and motion sensors to sense activity and illuminate the screen. The screen shall upload and download touch panel pages and graphical objects supplied by the control system software.

4. The system should be configured to operate automatically upon detection of video signal, but shall provide manual control of the system, including but not limited to:
   a. Preset scene selections
   b. System power on/off
   c. Audio/Video source selection and routing
   d. Audio controls (volume up, down, mute, etc.)
   e. Display On/Off
   f. Video Camera Control (Boardroom Only)
   g. Hardware Encoder Control (Boardroom Only)
5. Assembly, installation and setup shall be done according to instructions provided by the manufacturer.
6. All cables, adapters, and converters to connect the touch screen to the AV controller shall be provided as part of this project.
7. Touchpanel Display Size: Boardroom touchpanels shall be 10”, all other locations shall be 7”.
8. Mounting: Table mount
9. Power supply: Power Over Ethernet (POE).
10. Control: TCP/IP
11. Finish: Coordinate color with architect via submittal process prior to purchase
12. Basis of Design: Extron TLP Pro

2.9 CONFERENCING CAMERAS AND ACCESSORIES

A. Conferencing Cameras
   1. Provide a videoconferencing camera in conference rooms and in the Board Room, where shown in the drawing set.
   2. Camera shall include integrated extension port (RJ45), with up to 12x optical zoom to allow the Contractor to set the most appropriate optical view based upon the room’s size and configuration.
   3. Contractor shall include a recessed in-wall enclosure (999-2225-118 or equivalent) where the camera is mounted in a gypsum wall, or recessed in-ceiling enclosure (999-2225-150 or equivalent) where camera is mounted in a ceiling.
   4. PTZ control is not required in conference rooms but shall be configured in the boardroom.
   5. Camera shall feature:
      a. PTZ Capability
      b. 12x optical zoom, to allow the contractor to set the most optimal view
      c. 70-degree horizontal field of view
      d. Up to 1080p/60 Resolution
      e. Integrated RJ45 port for camera extension solution
      f. USB and HDMI interface ports
      g. Audio in and audio out, for USB software codec conferencing
      h. Camera available in white or black (coordinate color with architect via submittal process prior to purchase)
   6. Basis of design: Vaddio RoboSHOT 12E HDBT OneLINK Bridge System, with mounting accessories

B. Camera Processor and Controller
   1. Provide a camera matrix processor and production controller for the boardroom.
   2. Processor shall feature:
      a. 8x2 Video Switcher + Multiviewer Output
      b. Serial and ethernet control
      c. HDCP Compliant
   3. Basis of design: Vaddio AV Bridge MatrixMix and PCC MatrixMix Production Controller

C. Production PC
   1. Provide a Production PC for post-production editing of Boardroom meetings, as indicated in the drawing set.
   2. PC shall feature:
      a. Intel i7-10700 8-Core Processor
      b. Windows 10 Pro 64-Bit
      c. NVIDIA GeForce RTX 2060 6-Gb GDDR6
      d. 32-Gb DDR4 2933 MHz (2x16-Gb)
      e. 256-Gb PCIe Solid State Drive + 2-TB 7200 RPM 3.5” SATA Hard Drive
   3. Contractor shall include Adobe Premier Pro software with licensing
   4. Basis of design: Dell XPS Tower

2.10 AV RACKS AND CABINETS

A. Credenza AV Rack
   1. Provide and install an AV rack within a credenza (credenza provided by another discipline).
   2. The AV rack shall be a model which can be pulled out and rotated for maintenance.
   3. The AV rack shall provide 12U of rack space.
   4. Include an ultra-quiet fan kit. Coordinate fan kit color with architect via submittal process prior to ordering.
   5. Basis of Design: Middle Atlantic SRSR-2-12, AC Infinity AIRPLATE S5

B. Wall-Mounted AV Cabinet
   1. Provide and install a wall-mounted AV cabinet.
   2. The AV cabinet shall include minimum 18U of rack space.
   3. Include a rack-mounted ultra-quiet fan kit.
   4. Basis of Design: Middle Atlantic DWR-18-22PD, Middle Atlantic UQFP-4

C. AV Storage Drawer
   1. In each AV rack or cabinet, provide a 2U storage drawer for housing of manuals, microphones, and other accessories.
   2. Basis of design: Middle Atlantic TD2

D. Power Distribution Unit (PDU)
   1. In each AV rack or cabinet, provide two 2U PDUs.
   2. Each PDU shall provide 20-amp, 120-volt power to 14 NEMA 5-15 outlets, with surge protection.
   3. Basis of design: Chief NAXQ20

2.11 SIGNAL DISTRIBUTION (SWITCHING AND EXTENSION)

A. Presentation Switcher
   1. Provide Presentation Switchers as indicated in the drawing set.
   2. Presentation switcher shall include the following features:
      a. Fixed Input/Output ports, as required
      b. Matrix routing
      c. Up to 4K resolution
      d. Signal extension up to 100-meters
      e. Resolution scaling where required
      f. HDCP compliance
      g. EDID management
      h. Integrated Audio Digital Signal Processor
      i. Integrated Control Processor
      j. Integrated video scaling
   3. The integrated video scaler shall be configured for 1080p for initial testing, with specific evaluation of font size and legibility from all positions in the environment.
   4. Basis of design: Extron DTP CrossPoint 84 4K

B. Chassis-Based Matrix Switcher
   1. Provide a chassis-based matrix switcher for the boardroom.
   2. Switcher shall include the following features:
      a. Modular, card-based Input/Output ports, as required
      b. Matrix routing
      c. Up to 4K resolution
      d. Signal extension up to 100-meters
      e. Resolution scaling receivers available where scaling is required
      f. Remote powering of transmitters and receivers
      g. 50-Gbps digital backplane
      h. HDCP compliance
      i. EDID management
      j. I/O sizes up to 16x16
   3. Include all necessary XTP transmitters and receivers at the remote devices.
   4. Basis of design: Extron XTP II CrossPoint 1600

C. HDMI Transmitters/Receivers
   1. Provide HDMI transmitters and receivers as required.
   2. HDMI transmitters and receivers shall include the following features:
      a. Surface or recessed (wallplate) mount
      b. Up to 4K resolution
      c. Signal extension up to 100-meters

d. Analog audio input and output, as required
e. Control ports, as required

3. Basis of design: Extron DTP Series Extenders

D. HDMI Distribution Amplifier
1. Provide HDMI distribution amplifiers where indicated.
2. Distribution amplifiers shall feature:
a. HDCP compliance
b. EDID management
c. 18-Gbps bandwidth
3. Include optional mounting accessories, as required.
4. Basis of design: Extron DA HD 4K PLUS Series

E. Wireless Presentation Systems
1. Provide wireless presentation systems as indicated in the drawing set.
2. System shall allow wireless sharing from Apple® and Android™ mobile devices, as well as Mac® and Windows® computers.
3. System shall support 802.1X authentication.
4. Basis of design: Extron ShareLink Pro 500

F. USB Extenders
1. Provide recessed (wallplate) style and surface-mount style USB extenders as required.
2. USB extenders shall include the following features:
a. Decora style wallplate or surface mount enclosure, as required
b. USB 2.0 (and support backwards compatibility)
c. Signal extension up to 100-meters
3. Basis of design: Extron USB Extender Plus Series

G. USB Matrix Switching
1. Provide USB Extenders as specified within this section. These extenders shall connect to a network switch rather than being point-to-point connections.
2. Provide a USB Switching Controller to provide matrix routing of USB from peripherals to hosts.
3. Basis of design: Extron USB Plus Matrix Controller

H. USB Hub
1. Provide USB 3.0 Hub(s) as required.
2. USB hubs shall include the following features:
a. One Computer (Host) Port
b. Minimum of Two Peripheral (Device) Ports
c. USB 3.0 Compliant

I. IP KVM Switch
1. Provide an IP-based KVM switch for the displays located in the Safety and Security Office.
2. Solution shall feature:
a. Small form-factor switch which may be placed behind the display
b. Java-free, BIOS-level remote access of a remote PC
c. Support of up to eight (8) simultaneous sessions
3. Basis of design: Raritan KX IV-101

J. IP KVM Server
1. Provide a management server for the IP-based KVM solution.
2. A virtualized server shall be provided by the Owner, so the Contractor shall coordinate the server requirements and software installation with the Owner.
3. Management server shall provide a single, centralized, seamless access through multiple KC IV-101 switches.
4. Basis of design: Raritan CommandCenter

K. Audio Signal Cables: Balanced Mono
1. Cable shall be used to distribute balanced mono audio signals from field input devices to the audio processing headend.
2. Rating: UL 725, Listed for plenum applications
3. Conductor: Two (2) solid tinned copper conductors, overall shield, drain wire, and insulated. Size conductors as required for application, minimum 20-AWG.

L. Audio Signal Cables: 70V Mono
   1. Cable shall be used to distribute amplified audio signals to 70.7 V speakers.
   2. Rating: UL 725, Listed for plenum applications
   3. Conductor: Two (2) solid tinned copper conductors, insulated. Size conductors as required for application, minimum 18-AWG.

M. AV Twisted Pair Cable
   1. Provide four-pair shielded twisted pair (STP) cable for video (e.g. HDMI) extensions.
   2. The cable jacket shall be constructed of plenum-rated materials where required, and the cable jacket color shall be BLUE.
   3. Cable shall terminate using a shielded RJ45 pluggable connector at the transmitter equipment side and labeled with a wrap-around label. This end shall connect directly to the transmitter equipment without a patch bay.
   4. Cable shall terminate using a shielded RJ45 pluggable connector at the receiver equipment side and labeled with a wrap-around label. This end shall connect directly to the receiver equipment without a patch bay.
   5. The cable shall be certified to a minimum of 350-MHz at distances up to 330'.
   6. The cable shall be independently tested and verified to meet performance requirements set by the HDBase-T Alliance.
   7. The maximum cable length for horizontal copper STP cable from the transmitter to the receiver is 100 meters.

N. AV Control Cable: RS-232 Serial Data Cable
   1. Serial data cable shall contain two complete sets of foil shielded twisted pair signal conductors with a ground conductor and comply with TIA 232.
   2. Connector types shall be as required by the equipment.
   3. Serial data cable shall support transmission of RS-232 signals up to 300 meters.
   4. Cable jacket shall be riser rated PVC or plenum rated as required.
   5. Cable characteristics:
      a. Conductor Gauge: 24 AWG (7x32 AWG stranded).
      b. Characteristic Impedance: 100 ohms
      c. Capacitance between paired conductors: 12 pF/ft +/- 2 pF/ft.

O. AV Control Cable: Voltage Relay/Contact Closure
   1. Provide manufacturer approved cable for AV voltage relays and/or contact closures.
   2. Coordinate cable and voltage type for relays provided by other Contractors, including the Fire Alarm interface and Paging interface.

P. AV Low Voltage Power Supplies
   1. Provide only manufacturer approved low voltage power supplies, where separate power supplies are required.
   2. Input: 120 VAC
   3. Output: 12 or 24 VDC
   4. Mounting: Rack mounted or Surface mounted

Q. Network Patch Cables
   1. Provide Category 6 patch cables as needed.
   2. Comply with section 27 15 00.

R. Miscellaneous Hardware, Materials, and Associated Equipment:
   1. Provide and install all hardware, materials, custom panels, wall boxes, floor boxes, rack panels and associated equipment for the complete installation of this system as designed.
   2. Rack Accessories: Provide all rack/cabinet mounting kits and accessories including, but not limited to, fixed shelves, locking slide shelves, horizontal tray, vertical cabling ring section, vertical mounting rail and bracing kits.
   3. Cable Accessories: Provide all adapters, connectors, patch cables, interconnects, and accessories as required to complete the installation of all systems as designed and specified.
      a. Connectors, Adapters, Gender switchers, Patch panels, HDMI, HD-15, F-Type, XLR, 3.5mm mini type cables. Manufacturer: Extron or approved equal.

2.12 PERFORMANCE REQUIREMENTS

A. System Availability: At any given time, the overall AV shall be considered unavailable if the system is not available, not fully or accurately functional, or does not meet performance criteria for the given connection.

All AV components shall execute, without degradation, at the scheduled periods and response times for the systems to be considered available. The systems shall operate as specified twenty-four (24) hours per day, seven 7 days per week. Availability of the overall AV shall be at least 99.99% (52 minutes maximum downtime per year).

2.13 EXTERNAL INTERFACES

A. The Contractor shall coordinate with the Owner or the Owner's Representative for connectivity of the AV System(s) to the network(s), telephone system, Fire Alarm, and/or Paging systems.

B. Contractor shall include any interfaces to external systems (e.g. Fire Alarm) which may be required by NFPA Code.

2.14 EXPANSION AND SPARES

A. The Contractor shall clearly state limitations of the proposed system in terms of adding additional capacity including limitations for the number of devices per circuit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements and other conditions affecting the performance of the Audio/Visual Systems. Advise Consultant immediately in writing of any discrepancies between field conditions and drawings that affect subject Work. Do not proceed until unsatisfactory conditions have been corrected.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

3.2 ASSET TAGGING

A. All equipment of greater than $500 value, and otherwise as directed by Owner, shall be asset tagged in the Owner's Inventory System by the Contractor. Asset tags and inventory control sheet are to be obtained from Owner. Signed, completed inventory control sheet detailing equipment description, location, serial number, label name, if any, and asset number assigned shall be included in as-built documents.

3.3 INSTALLATION

A. Installation shall include the delivery; unloading; setting in place; fastening to walls, floors, ceilings, counters, and other structures where required. Interconnecting wiring of the system components, equipment alignment and adjustments, and all other Work whether or not expressly required herein which is necessary to result in a complete operational system. Install system in accordance with National and/or Local applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. During installation, and up to the date of final acceptance, the Contractor shall be under obligation to protect his finished and unfinished Work against damage and loss. In the event of any such loss or damage, the Contractor shall replace or repair such Work or equipment at no cost to Owner.

C. Install plumb and level and secured in accordance with manufacturer's instructions.

D. Additional requirements for the installation of Audio Video Systems:
   1. Program all capable audio video devices EDID so that the system will self-coordinate and lock audio and video signals from source to output device. Signals shall be coordinated to provide native formats from the source to the output where possible.
   2. Ensure firmware is updated to the most current release for all devices.
   3. Form separate groups for the following:
      a. Power.
      b. Control cables.
      c. Video cables.
      d. Audio cables carrying signals less than -20 dBm.
      e. Audio cables carrying signals between -20 dBm and +20 dBm.

f. Audio cables carrying signals above +20 dBm.

4. Route all cable and wiring within equipment racks, cabinets and millwork according to function, separating wires of different signal levels (microphone, line level, amplifier output, AC, control, etc.) by as much distance as possible. Neatly arrange, harness and bundle all cable with nylon ties.
5. Observe proper circuit polarity and loudspeaker wiring polarity. Clearly label connections and wires as to function and polarity. Wires patch panels and connectors as follows:

WIRE	CONNECTOR	SIGNAL
Red or White	Pin #2	Hi or POS
Black	Pin #3	Lo or Neg
Shield	Pin #1	Ground/ Common

6. Cables shall not be wired with a polarity reversal between connectors at either end. Take special care when wiring microphone cables to ensure that constant polarity is maintained.
7. Provide all circuits, balanced and floating, except as noted in these specifications or directed by the Owner at the time of final equalization and testing.
8. Make all solder connections with rosin-core solder. Use temperature-controlled soldering irons rated at least 60 watts for all soldering work. No soldering guns, gas or butane, or temperature-unregulated irons will be allowed on the job site. (The presence of such soldering tools on the job site will constitute evidence of solder connections made with unauthorized tools and will be grounds for rejection of all solder connections in the system and the subsequent re-work of same.)
9. When wiring within enclosures, provide adequate length of conductors. Bundle, and lace the conductors to terminal points with service loop. Provide and use lacing bars where appropriate. Cabling shall be neatly strapped, dressed, and adequately supported.
10. Make splices, taps, and terminations on numbered terminal strips in junction boxes, outlet boxes, and equipment enclosures.
11. The use of wire nuts at any point within the system is unacceptable. The sole exceptions are as follows:
    a. AC circuit connections within equipment rack junction boxes.
    b. Splicing outdoor speaker cables. These wire nuts shall be underground rated and filled with a silicone-based sealant.
12. Utilize plated or tinned copper spade lugs, of appropriate size to the application. Except for the use of mil spec lugs, all crimp connectors in audio paths shall be soldered as well as crimped. Only uninsulated lugs shall be used.
13. Speaker wiring terminating on amplifiers equipped with a screw-down terminal strips shall be connectorized with forked lugs
14. Install control circuits in accordance with NFPA 70 and as indicated. Provide the number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
15. Install all cabling with a bend radius of no less than is recommended by the cable manufacturer.
16. All cables shall be marked with wrap-around number or letter cable markers at both ends with clear shrink tube covering the label. There shall be no unmarked cables at any place in the system. All cable markings shall correspond with system wiring diagrams and as-built documentation.

E. System Grounding:
1. Racks: Audio racks must not connect electrically to the conduits. All conduits terminating at the equipment rack must terminate through insulated fittings to isolate conduit grounds from the equipment rack grounds. Electrically isolate audio equipment racks from all grounds with the exception of a single low impedance connection to technical ground. Provide a copper grounding buss in each equipment rack for isolated technical grounding of all equipment. Connect the common point of each rack frame and that rack's grounding buss to the isolated technical ground common point via an insulated copper conductor no smaller than 6 AWG. Connect the frames of all audio equipment racks to the isolated technical ground buss.
2. Equipment: A separate 12-gauge copper insulated ground conductor shall connect the chassis of each piece of equipment to the ground buss. Connections to the buss shall be secured by machine screws at holes, which are drilled and tapped. All connections shall be properly crimped and soldered as provided elsewhere.
3. Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground.
4. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 0.1-ohm ground at main equipment location. Measure, record, and report ground resistance. Provide isolation transformers as necessary.

3.4 TECHNICAL GROUNDING:

A. All equipment within the technical power system will be grounded back to the technical reference ground using an isolated star grounding system. Technical ground is insulated and isolated from all other systems, except at the electrical connection where the master technical ground connects to the neutral bus, and ground electrode system at the service entrance equipment.

3.5 DOCUMENTATION

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 01 of the Project Manual, or a minimum of four (4) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues.
   2. Provide above closeout documentation as an electronic file in PDF format.

B. Warranty and Maintenance:
   1. Record Drawings.

3.6 MAINTENANCE AND SUPPORT

A. Contractor shall provide a price for an extended Warranty and Operations Maintenance Services Agreement for the Systems as a whole.

B. Refer to WARRANTY located in Part 1 of this document for additional details.

3.7 TRAINING

A. On-Site Training: A minimum of twenty-four (24) hours of training shall be provided. The Contractor shall structure the course(s) to describe all systems, software and applications and support programs.

B. The following training guidelines shall be followed:
   1. By means of training classes augmented by individual instruction as necessary, the Contractor shall fully instruct the Owner's designated staff in the operation, adjustment and maintenance of all products, equipment and subsystems. The Contractor shall be required to provide all training aids (e.g., notebooks, manuals, etc.).
   2. All training shall be completed a minimum of one week prior to the system becoming operational and utilized by the Owner. Training schedule is subject to the Owner's approval.
   3. Training shall be conducted by experienced personnel and supported by training aids. An adequate amount of training material shall be provided by the Contractor. The following is considered a minimum:
      a. Operations and flow charts, overall block diagrams, and descriptive material with "screen shot" images for all software
      b. Schematic drawings for each of the hardware components
      c. All procedure manuals, specification manuals, and operating manuals
      d. As-built drawings
   4. Participants shall receive individual copies of technical manuals and pertinent documentation 7-days in advance of the training course.
   5. The courses shall be scheduled such that the Owner's personnel can participate in all courses (no overlap).

3.8 ACCEPTANCE

A. Arrange with the Owner to provide a quiet, controlled, and secure environment for the duration of system testing.

B. The Contractor shall provide a complete rehearsed demonstration of all system operations. This demonstration shall include all needed test discs and signal sources. Include any required computer sources, DVD player, pre-recorded video test discs, CCTV feed, and CATV feed.

C. Provide all test equipment required to complete the acceptance test. Phase analyzers, extension cables, tools, oscilloscopes, oscillators, test generators, including, but not limited to, a video test generator that emulates the computer scan frequencies required in these specifications, and all other miscellaneous equipment, shall be supplied by the Contractor as necessary to complete testing.

D. Maintain and submit a check-off list of all required tests for reference by the Project Manager before the acceptance tests begin.

E. The performance demonstration of the completed system includes the Contractor and the user media staff examining all cable trays, equipment placement, and rack wiring to ensure installation was completed in compliance with the specifications.

F. During performance tests, equipment shall be operated under standard conditions as recommended by the manufacturer. The signal paths for performance standards shall be as follows:
   1. Video systems shall be tested from the most remote input connections for switchers through the most remote output connectors from the switchers.
   2. Control system shall be tested from the control interface (touch panel).
   3. The computer interfaces shall be tested using on-line signals from various computers. Demonstrate and test any and all floor box / wall outlet locations.

G. This acceptance testing includes, but is not limited to the following:
   1. Check audio and video systems, including inputs and outputs, for compliance with performance standards.
   2. Check remote control functions from all origination points to all controlled locations for proper operation.
   3. Check all video systems for uniform brightness, focus, and compliance with the manufacturers published specifications.
   4. Adjust, balance and tune all equipment, as required, for optimum quality.
   5. Establish, index and tabulate normal settings for all level controls. These settings will be recorded on the final “as-built” system drawings for reference.
   6. Check all functions of the video displays, video switcher, PC interfaces, and digital video scalers to ensure that the performance of these systems is in compliance with requirements.

END OF SECTION

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SECTION 28 05 00

COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Electronic Access Control Systems

B. Video Surveillance Systems

C. Grounding and Bonding

D. Cable Pathways

E. Cable management

1.2 RELATED WORK SPECIFIED UNDER OTHER DIVISIONS

A. Foundations and pads required for equipment furnished under this Division.

B. Field painting, except such painting as is required to maintain shop coat painting and factory finish painting.

C. Flashing of conduits into roofing and outside walls.

D. Heating, ventilating and air conditioning equipment.

E. Electrical service to equipment rooms.

F. Cutting and patching for low voltage systems work, except for errors and omissions under this Division.

1.3 QUALITY ASSURANCE

A. Comply with applicable local, state and federal codes.

B. Comply with applicable requirements of recognized industry associations which produce standards for the various trades.

C. Warrant Work under this specification against faulty material or Workmanship in accordance with Division 01. If the project is occupied or the systems placed in operation in several phases at the request of the Owner, then the warranty of each system or piece of equipment used shall begin on the date of substantial completion for each phase. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.

D. Equipment and material provided under this Division shall be periodically inspected and serviced by competent installers. This function becomes the responsibility of the Owner once the system is accepted by the Owner. The one year material and workmanship warranty is not intended to supersede normal inspection or service and shall not be construed to mean the Contractor shall provide free service for normal maintenance items such as periodic cleaning and adjustment due to normal use, nor to correct without charge, breakage, maladjustment and other trouble caused by improper maintenance.

E. Upon completion of contract and progressively as work proceeds, clean-up and remove dirt, debris and scrap materials. Maintain the premises in a neat and clean condition at all times during construction. Protect and preserve access to head-end equipment at all times. Clean items with factory finishes. Touch-up minor damage to surfaces; refinish entire piece of equipment when sustained major damage. All electronics must be protected from dust and other airborne debris. Contractor shall identify all types of quality control mechanisms they employ. List all types.

1.4 STANDARDS

A. The Contractor's performance of the Work shall comply with applicable federal, state and local laws, rules and regulations. The Contractor shall give required notices, shall procure necessary governmental licenses, permits, and inspections and shall pay without burden to The Owner, all fees and charges in connection therewith unless specifically provided otherwise. In the event of violation, the Contractor shall pay all fines and penalties, including attorney's fees and other defense costs and expenses in connection therewith.

B. Federal Communications Commission
   1. Equipment requiring FCC registration or approval shall have received such approval and shall be appropriately identified.

C. Codes, Standards and Ordinances
   1. Design, manufacture, test and install telecommunications cabling networks per manufacturer's requirements and in accordance with NFPA-70(National Electrical Code®), state codes, local codes, requirements of authorities having jurisdiction and particularly the following standards:
      a. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2015
      b. ANSI/NECA/BICSI-568 – Standard for Installing Commercial Building Telecommunications Cabling, 2006
      c. ANSI/TIA/EIA Standards
         1) ANSI/TIA-606-C – The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2017
         2) ANSI/TIA-607-D – Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002
      d. NFPA-70 – National Electrical Code
      e. Federal, state, and local codes, rules, regulations, and ordinances governing the Work, are as fully part of the specifications as if herein repeated or hereto attached. If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Owner's Representative in writing. Where the requirements of other sections of the specifications are more stringent than applicable codes, rules, regulations, and ordinances, the specifications shall apply.
      f. American Society for Testing and Materials (ASTM): ASTM E. 814 – Standard Test Method for Fire Tests of Penetration Firestop Systems
      g. Underwriters Laboratories, Inc. (UL): UL 1479 – Tests of Through-Penetration Firestop Systems
      h. Americans with Disabilities Accessibility Guidelines
      i. Code of Federal Regulations, Title 29, Chapter XVII, Part 1910 (OSHA)
      j. Uniform Building Code (UBC)
      k. International Building Code (IBC)
      l. Applicable codes and directives of authorities having jurisdiction

1.5 COMPLETENESS OF WORK

A. The Contract Documents depict low voltage systems which are intended to be complete and functioning systems. All products, materials, labor, and programming necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the Contractor.

B. Catalog numbers referenced throughout this Division's drawings and specifications are intended to convey a general understanding of the type of quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra charge shall be allowed because a catalog number is found to be incomplete or obsolete.

1.6 PRE-INSTALLATION CONFERENCE

A. Arrange and schedule pre-installation conference prior to beginning any work of this section Communications.

B. Agenda: Clarify questions in writing related to work to be performed, scheduling, coordination, etc. with consultant and/or project manager/Owner representative.

C. All individuals, who will be in an on-site supervisory capacity, shall be required to attend the pre-installation conference. This includes project managers, site supervisor and lead installers. Individuals who do not attend the conference will not be permitted to supervise the personnel that install, terminate or test communications cables on the project. The Contractor's RCDD that will oversee the installation is required to attend the pre-installation conference.

D. The manufacturer that will be providing the extended warranty is required to have a representative attend the pre-installation conference.

1.7 SEQUENCE AND SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and if accepted will be used to track work status.

B. Work should be scheduled not to interfere with day-to-day operations within the facility. Operations vary by area and should be given careful consideration in relation to the schedule.

C. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

D. Submit schedule for installation of equipment and cabling. Indicate delivery, installation and testing for conformance to specific job completion dates. As a minimum, dates are to be provided for bid award, installation start date, completion of station cabling, completion of riser cabling, completion of testing and labeling, cutover, completion of the final punch list, start of demolition, Owner acceptance and demolition completion.

1.8 SUBMITTALS

A. Comply with provisions of Division 01.

B. Provide all submittal requirements under this section as a single package.

1.9 ALTERNATES, SUBSTITUTIONS AND CHANGE ORDERS

A. If a proposed alternate material is equal to or exceeds specified requirements, Contractor shall provide manufacturer’s specifications in writing for written approval prior to purchase and installation of proposed materials. The proposed material substitution shall not void or change manufacturer’s warranty.

B. Contractor shall provide a complete cabling infrastructure according to these written specifications and drawings. If the Owner changes the scope of work to be performed by the Contractor, it shall be in writing. Contractor shall respond to these changes with a complete material list, labor, and taxes in writing presented to the Owner for approval. Contractor shall not proceed with additional scope of work without a signed approval by the Owner.

C. Additional work performed by the Contractor will not be paid by Owner without signed approval of these changes prior to implementing changes. Submit a copy of signed change order upon billing.

1.10 USE OF THE SITE

A. Use of the site shall be at the Owner’s direction in matters in which the Owner deems it necessary to place restriction.

B. Access to the building wherein the Work is performed shall be as directed by the Owner.

C. The Owner will occupy the premises during the entire period of construction for conducting his or her normal business operations. Cooperate with the Owner to minimize conflict and to facilitate the owner’s operations.

D. Schedule necessary shutdowns of plant services with the Owner and obtain written permission from the Owner. Refer to article - CONTINUITY OF SERVICES herein.

E. Proceed with the Work without interfering with ordinary use of streets, aisles, passages, exits and operations of the Owner.

F. All Contractor personnel must check in with the facilities engineering department and/or the General Contractor upon arrival and upon departure.

1.11 DELIVERY AND STORAGE

A. Insofar as possible, deliver items in manufacturers' original unopened packaging. Where this is not practical, cover items with protective materials, to keep them from being damaged. Use care in loading, transporting, unloading and storage to keep items from being damaged.

B. Store items in a clean dry place and protect from damage.

C. Storage space on project site may be limited. The Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

D. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

E. Provide protective covering during construction to prevent damage or entrance of foreign matter.

F. Contractor is responsible for on-site security of tools, test equipment and materials.

G. Replace at no expense to the Owner, product damaged during transporting, storage, handling or the course of construction.

1.12 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 1 of the Project Manual and any applicable supplements. The number of submittal sets required is the greater of either the requirements of Division 1 of the Project Manual, or a minimum of four (4) sets.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues
   2. Test reports on all systems (electronic file format and hard copy)
   3. As-built door and device schedules
   4. As built documentation of all systems installed under this project
   5. As built documentation of TR modifications and associated cabinet and wall elevations

B. Warranty and Maintenance:
   1. Test Report Binder(s)
   2. Record Drawings

1.13 RECORD DRAWINGS

A. Keep a hard copy set of project drawings at the job site exclusively for recording deviations from the Construction Drawings.

B. Record locations and depths of buried and concealed conduits from fixed, easily identifiable objects, such as building walls. Where conduits are concealed in walls, indicate distances off of building corners or other building features not likely to be disturbed by future alterations.

C. Mark deviations in a different color so that work of various systems can be easily identified.

D. When Work is completed, record all deviations in an electronic format using AutoCAD 2007 in a format usable to the Owner. Coordinate this format with the Owner.

E. Submit two copies of completed "record drawings" on electronic media such as CD or DVD to Owner's Representative for distribution.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All materials and equipment used in carrying out these specifications are to be new and have UL listing, or listing by other recognized testing laboratory when such listings are available.

B. Model numbers and manufacturers included in this specification are listed to establish as standard of product quality.

C. Other qualified manufacturers may be substituted only with The Owner's written consent. To request a substitution, the Contractor shall submit complete technical data, samples, and if requested, results of independent testing laboratory tests of proposed equipment.
   1. If the proposed System includes equipment other than specified model numbers, submit a list of major items and their quantities, with a one-line schematic diagram for review.
   2. Material not specifically identified within this document but which is required for the successful implementation of the intended system(s), shall be of the same class and quality as the specified material and equipment.
   3. Include a list of previously installed projects using proposed equipment that are similar in nature to specified system.

PART 3 - EXECUTION

3.1 COORDINATION

A. Insofar as it is possible to determine in advance, advise the General Contractor to leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should the Contractor neglect doing this, any cutting and/or patching required is to be done at this Contractor's expense. Visit site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work involved.

B. Carefully coordinate with other divisions to ensure proper power requirements, grounding, fireproofing and interlocking controls between the fire alarm system, security system, and other owner furnished systems.

C. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interferences between work of various Contractors to be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to the Owner.

D. The Owner or the Owner's Representative shall be the mediating authority in all deviation and disputes arising on project.

E. Coordinate with local telephone and cable service providers to assure that proper points of service, demarcation location and grounding requirements are in accordance with contract drawings. Duct bank is to be provided by Division 26. This Contractor shall be involved regarding discussions about services to the building.
   1. Coordinate with other trades to provide wall and ceiling access panels wherever required for access to communication equipment.

F. Intent:
   1. These sections of specifications and drawings form a complete set of documents for communications systems for this project. Neither is complete without the other. Any item mentioned in one shall be as binding as though mentioned in both.
   2. The intent of these specifications and drawings is to form a guide for a complete systems installation. Where an item is reasonably necessary for a complete system but not specifically mentioned, such as pull boxes, fittings, expansion fittings, support hangers, etc. provide same without additional cost to Owner.
   3. Communication equipment room layouts indicted on drawings are diagrammatical only. The exact location of outlets and equipment to be coordinated and governed by project conditions. The Designer reserves the right to make any reasonable changes (approximately 6 feet) in location of junction boxes or equipment prior to roughing in of such without additional cost to Owner.

G. Deviations:
   1. No deviations from specifications and drawings to be made without full knowledge and consent of the Designer.
   2. Should the Contractor find during progress of work that existing conditions make desirable a modification of the requirements of any particular item, report such item promptly to the Designer for his decision and instructions.

H. Main Horizontal Pathway/Raceway:

1. Unless otherwise noted on the drawings, all communications/low voltage systems cabling shall be routed above accessible corridor ceilings parallel to room walls and corridors via cable tray or J-hook supports. Cabling shall be segregated by function as follows:
   a. Voice/data cabling
   b. All other systems

3.2 CONTINUITY OF SERVICES

A. The Contractor shall not take any action that will interfere with, or interrupt, existing building services unless previous arrangements have been made with the owner's representative. Arrange the Work to minimize shutdown time.

B. Owner's personnel will perform shutdown of operating systems. The Contractor shall give three (3) days' advance notice for systems shutdown.

C. Should services be inadvertently interrupted, immediately furnish labor, including overtime, material, and equipment necessary for prompt restoration of interrupted service.

3.3 TRENCHING, EXCAVATION, BACKFILLING AND REPAIRS

A. Trenching, Excavation and Backfilling is the responsibility of the General Contractor. This Contractor is to coordinate all requirements with the GC. Failure to properly coordinate this effort resulting in additional trenching, excavation, backfilling or repairs shall be performed without additional cost to Owner.

3.4 PLYWOOD BACKBOARD AND WALL BACKING

A. Contractor shall provide 4' W x 8' H x 3/4" D fire retardant plywood backboard as indicated in all Communication Rooms. Plywood is to be painted with two coats of flat white fire retardant paint on all six sides and installed 6" above finished floor. The fire rating on the plywood shall be masked prior to painting and the mask removed after installation such that the fire rating is always visible.

B. General Contractor is to provide appropriate backing in walls as required for mounting brackets and other wall mounted equipment per manufacturer requirements.

C. Where work is to be done in an existing Telecommunication Room (TR), the Contractor shall ensure plywood in the TR is flame retardant. If the existing plywood does not comply the Contractor shall replace it with plywood compliant with 3.4-A.

3.5 FIRESTOPPING

A. Select appropriate type or types of through penetration firestop devices or systems appropriate for each type of communications penetration and base each selection on criteria specified herein.

B. Selected systems shall not be less than the hourly time delay ratings indicated in the Contract Documents for each respective fire-rated floor, wall or other partition of building construction. Firestop for each type of communications penetration shall conform to requirements of an independent testing laboratory design drawing or manufacturer's approved modification when used in conjunction with details shown on the Drawings.

C. Perform all necessary coordination with trades constructing floors, walls or other partitions of building construction with respect to size and shape of each opening to be constructed and device or system approved for use in each instance.

D. Coordinate each firestop selection with adjacent Work for dimensional or other interference and for feasibility. In areas accessible to public and other "finished" areas, firestop systems Work shall be selected, installed and finished to the quality of adjacent surfaces of building construction being penetrated.

E. Use materials that have no irritating or objectionable odors when firestopping is required in existing buildings and areas that are occupied.

F. Provide damming materials, plates, wires, restricting collars and devices necessary for proper installation of Firestopping. Remove combustible installation aids after firestopping material has cured.

G. All firestops shall be installed in accordance with the manufacturer's instructions in order to maintain the specific rating assigned by the independent testing laboratory.

H. Existing raceways, cable trays and cabling that penetrate existing building construction shall be firestopped to the extent necessary to fill cavities that may exist between existing building construction and existing communications penetrations or existing conduit sleeve, and between existing conduits and existing conduit sleeve.

I. If required by inspecting authorities:

J. Expose and remove Firestopping to the extent directed by inspecting authority to permit his or her inspection

K. Reinstall new firestopping and restore Work where removed for inspection

3.6 TESTS

A. On completion of Work, installation shall be entirely free of damaged conductors, software errors, incomplete jack termination including labeling and faceplates and dust. Perform a thorough operation test in the presence of the Owner or their representative. Provide documentation of all test results as outlined in each system's specifications. Include labor, materials and instruments for above tests.

B. Furnish to the Owner, as a part of closing documents, a copy of such tests including identification of each cable, also the dedicated communication service ground test as required by each systems individual manufacturer indicating compliance with their requirements.

C. Prior to final observation and acceptance, test and leave in satisfactory operating condition, all systems and equipment including but not limited to the following:
   1. Grounding
   2. Firestopping of all sleeves and conduits
   3. Telephone and LAN systems
   4. Turn in test results on cabling

3.7 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, dust, and construction debris and repair damaged finish, including chips, scratches and abrasions. This includes touching up paint removed for grounding.

B. Contractor shall provide a clean work environment, free from trash/rubbish accumulated during and after cabling installation.

C. Maintain construction materials and refuse within the area of work. Clean the work area at the end of each day.

D. Contractor shall keep all liquids (drinks, sodas, etc.) off finished floors, carpets, tiles, racks and equipment. If any liquid damage to above finishes or equipment, Contractor shall provide professional services to clean or repair scratched/soiled finishes or damaged equipment at own expense.

3.8 INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for communication systems installation. Work shall not start until all permit applications are approved.

3.9 OBSERVATIONS

A. When field observation services are a part of the project scope, the Designer's office will provide periodic observation of the progress of Work specified herein. The purpose of the observation service is to ensure compliance of Contractor's Work with specifications and drawings. The Designer's office may also observe tests required of this Contractor as called for in other sections of the specifications.

B. Specifications and drawings represent Work to be done in view of total project requirements. To eliminate possible conflict with other trades, final location of conduits, jacks, outlets, components, etc., is the responsibility of this Contractor. Contractor to provide all supervision required for his personnel to ensure that installation is made in accordance with specifications and drawings and all safety rules and regulations are observed. In the event of conflicts of Work on project with other trades, Contractor is to make every reasonable effort to resolve conflict through meetings and discussions with other parties involved, by preparation of drawings or other appropriate action. Only after this has been done shall the Designer's assistance be requested through the RFI process.

C. When the Designer is requested to visit the project to aid in resolution of conflicts, or for witnessing tests, he shall be given a minimum of 48 hours' notice prior to time their presence is requested at job site.

3.10 WARRANTY GUARANTEE

A. The Designer reserves the right to accept or reject any part of the installation which does not successfully meet requirements as set out in these specifications.

B. This Contractor shall, and hereby does, guarantee all Work installed under this division shall be free from defects in workmanship and materials for a period of one year from date of final acceptance. This Contractor further agrees to repair or replace any defective material or workmanship which is or becomes defective within the terms of this warranty-guarantee.

C. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

3.11 METHOD OF MEASUREMENT

A. Cabling pathways shall be measured in lineal feet. Electronic access control systems, video surveillance systems, cable management shall be measured in each unit.

3.12 METHOD OF PAYMENT

A. Payment shall be made at the contract unit price based on the measurements listed herein. Payment shall be full compensation for all labor, materials, tools, equipment and incidentals required to complete the work specified herein and on the drawings.

END OF SECTION

SECTION 28 10 00

ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and equipment for the complete installation of Work called for in the Contract Documents.

B. This section includes the minimum requirements for the installation of electronic access control, intrusion detection and video surveillance systems.

C. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Intrusion Detection System
   2. Door Position Sensors
   3. Electronic Locking Devices
   4. Credential Readers
   5. Field Panels, Power Supplies and Batteries
   6. Video Surveillance Cameras
   7. Video Surveillance Server
   8. Duress System

1.2 DEFINITIONS AND TERMS

A. Trade association names and communications terminology are frequently abbreviated. The following acronyms or abbreviations may be referenced within this Section:
   1. ACS Access Control System
   2. AHJ Authority Having Jurisdiction
   3. ANSI American National Standards Institute
   4. AVI Automatic Vehicle Identification
   5. AWG American Wire Gauge
   6. BICSI Building Industry Consulting Service International
   7. EIA Electronics Industries Association
   8. EPT Electrical Power Transfer
   9. NECA National Electrical Contractors Association
   10. NEMA National Electric Manufacturers Association
   11. NFPA National Fire Protection Association
   12. OAR Owner’s Authorized Representative
   13. PIR Passive Infrared
   14. RFP Request for Proposal
   15. STD Standard
   16. TGB Telecommunications Grounding Busbar
   17. TIA Telecommunications Industry Association
   18. TMGB Telecommunications Main Ground Bus Bar
   19. UL Underwriters Laboratories
   20. UPS Uninterruptable Power Supply
   21. VMS Video Management System
   22. VSS Video Surveillance System

1.3 QUALITY ASSURANCE

A. The Texas Department of Public Safety requires that portions of this work defined as regulated under the provisions of SB 1252, 78th Legislative Session of the State of Texas be performed by a contractor holding a valid and current Class B Security Contractor Company License.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the OAR.

C. Comply with NEC as applicable to construction and installation of security system components and accessories.

D. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the OAR.

E. Contractor's Qualifications:
1. Firms regularly engaged in the installation of Electronic Access Control systems and that have five (5) years of installation experience with systems similar to that required for this project. The Contractor shall have been actively engaged in installing, maintaining and operating similar systems and services as outlined in this document.
2. Provide references to include client names, phone numbers and a summary of project details. These references will be checked, and the clients will be asked questions relative to the performance of your company.
3. Provide verification that installation personnel responsible have been properly trained to install the products described in this Section.
4. Provide full time project manager with a minimum of ten (10) years field experience in installation of communications systems and infrastructures. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the OAR.

F. Manufacturer's Qualifications:
1. Firms regularly engaged in manufacture of products of the types, ratings and capacities required for this project; whose products have been in satisfactory use in similar service for not less than five (5) years, with production capabilities per applicable NEMA standards.

G. Material and Work specified herein shall comply with the applicable requirements of:
1. NECA 1 – Standard Practice of Good Workmanship in Electrical Construction, 2015
2. ANSI/NECA/BICSI-568 – Standard for Installing Commercial Building Telecommunications Cabling, 2006
3. ANSI/TIA-606-C – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2017
4. ANSI/TIA-607-D – Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2019
5. NFPA 70 – National Electric Code, 2017
6. IBC - International Building Code, 2015
7. UL 13 – Standard for Safety for Power-Limited Circuit Cables
8. UL 294 – Standard for Access Control System Units, 2009
9. UL 444 – Standard for Safety for Communications Cables
10. UL 497B – Standard for Protectors for Data Communications and Fire-Alarm Circuits
11. UL 681 – Standard for Safety Installation and Classification of Mercantile and Bank Burglar Alarm Systems
12. UL 969 – Standard for Marking and Labeling Systems
13. UL 1037 – Standard for Safety Antitheft Alarms and Devices, Third Ed.
14. UL 1076 – Standard for Proprietary Burglar Alarm Units and Systems, Fourth Ed.
15. IEEE 802 – Local Area Network Standard
16. Title 47 CFR Part 15 – Radio Frequency Devices
17. NFPA 70 – National Electric Code, 2008
18. BICSI – Telecommunications Distribution Methods Manual, 13th Edition, 2009
19. Applicable codes and directives of authorities having jurisdiction

H. Work:
1. The Work shall be performed in compliance with the applicable manufacturer's installation instructions, Standards, and certifications listed herein, the Contract Documents, and governing codes and regulations of the authorities having jurisdiction.
2. The drawing and specification requirements govern where they exceed Code and Regulation requirements.
3. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
4. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

1.4 CONFLICTS

A. This installation shall be made in strict accordance with the Specifications, Drawings, any applicable codes, referenced publications and standards. In case of conflicts between the aforementioned, notify the OAR in writing prior to commencement of affected work.

1.5 PERMITS

A. The Contractor shall secure and pay for all necessary permits and fees required for the execution of this Work. Work will not start until all permit applications are approved.

1.6 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by OAR, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed. This schedule shall be submitted with the bid and, if accepted, will be used to track work status.

B. The successful Contractor for all or any portion of the work described by this RFP package will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.7 REQUIREMENTS

A. All references to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction. The OAR must approve material submittal and substitutions in writing.

B. Verification that all the components specified and installed meet the criteria specified by the respective component manufacturer, supplier and designer is the responsibility of the Contractor.

C. All installation tools, special equipment and testing apparatus required to accomplish field connections and related work as described herein shall be furnished by the Contractor at no additional cost.

D. The requirements as given in this document are to be adhered to unless revised by the OAR in writing.

E. The Owner reserves the right to waive these requirements at any time.

1.8 SUBMITTALS

A. Provide all submittal requirements under this section as a single package.

B. Submit manufacturer's data on Access Control System components including, but not limited to, electrical specifications, mechanical specifications, rough-in diagrams, and instructions for installation, operation and maintenance, suitable for inclusion in maintenance manuals.

C. Provide Shop Drawings showing equipment/locations and arrangements. Provide an assembly drawing of every equipment rack and card cage enclosure with location and dimensions shown. Provide wiring diagrams showing all field connected wiring.

D. Prepare and submit Phased System Testing documents and plans, Final Testing and Acceptance Plans, Test Procedures, Test Reports, and System Availability Test documents as described in this specification section.

1.9 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit a minimum of four (4) sets of close-out documentation.
   1. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues. Include a CD, or flash drive, containing a PDF version of the binder contents.
   2. A record drawing set, and supplemental documentation shall be compiled after system fabrication and testing and shall incorporate any changes made after Shop Drawing submittal.
   3. The documents shall include wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment making up the system may be easily identified by going to the actual equipment and making reference to this information. Every terminal, wire, component, or piece of equipment, relay, and other such items shall have a number or letter designation.

4. Provide above closeout documentation as an electronic file in PDF format. Include the following:
   a. Record drawings, with functional block diagrams, schematics, floor plans, wall fields and rack layouts.
   b. Operation & maintenance manuals for each piece of equipment installed.
   c. Manufacturer warranty cards and related information for each device.
   d. All source code and configuration files for the various control system components, digital signal processors and other programmable devices. If a component fails in the future, these files will be required to configure its replacement.

B. Turn over all keys and combinations to racks, enclosures, and any equipment equipped with locks.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials factory-packaged in containers or reels and handle in accordance with manufacturer's recommendations. Store in a clean, dry space and protect products from damaging fumes and traffic. Handle materials carefully to avoid damage.

B. Storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the OAR.

C. Components sensitive to damage in a harsh environment shall be stored off-site and delivered as needed.

D. Provide protective covering during construction to prevent damage or entrance of foreign matter.

E. Contractor is responsible for on-site security of tools, test equipment and materials.

F. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.11 PROJECT CONDITIONS

A. Verify conditions on the job site are applicable to this Work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install Work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the Work may be installed.

1.12 WARRANTY

A. Warrant labor and product to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics for one (1) year after the date of acceptance. Repair or replace defects occurring in labor or product within the Warranty period without charge.

B. All surplus parts and pieces to the installation shall be maintained as a spare parts inventory at the building site. Parts replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

PART 2 - PRODUCTS

2.1 GENERAL

A. Portions of this section are entirely performance-based. This contractor is expected to select an appropriate solution that meets the requirements below, design the system and install it.

B. References to manufacturers, model numbers and other pertinent information herein are intended to establish standards of performance and quality of construction.

C. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the statement of work. Except where described in the SUMMARY subpart of this document, the contractor is responsible for providing any other parts and materials needed to deliver a complete and working system.

2.2 INTRUSION DETECTION SYSTEM

A. Intrusion Detection System Panel
1. Install Zone Expanders where needed.
2. System to provide the ability to send alarm signals over the Internet.
3. System shall utilize hard-wired zones for all devices.
4. Install keypads where shown on drawings.
5. Acceptable products:
   a. Honeywell Vista 20P.
   b. Honeywell 4219 Zone Expander.
   c. Approved equivalent.

B. Door Contacts
1. Provide recessed door contacts on doors monitored by the intrusion detection system.
2. Contact shall allow for up to 5/8" gap for steel doors.
3. Contact to be 3/4" diameter.
4. Acceptable products:
   a. Bosch ISN-CSD70
   b. Honeywell MPS70WG
   c. Approved equivalent

C. Passive Infrared/ Microwave Motion Detector
1. Install combination passive infrared and microwave technology motion detectors as shown on the design drawings, connected to the intrusion detection system.
2. Detector to be ceiling mount.
3. Detector shall be compensated for variances in room temperature.
4. Detector shall be equipped with a variable sensitivity adjustment.
5. Acceptable products:
   a. Bosch DS9370
   b. Approved equivalent

D. Duress Button
1. Install duress buttons at reception desks.
2. Installer will coordinate with owner on exact placement.
3. Terminate the duress button to the intrusion detection controller in IDF A226. The zone will be identified by the owner.
4. Acceptable products:
   a. ~~Bosch ND-100 GLT Panic Button and accessory cap with cover~~ Alarm Controls RP-44
   b. Approved equivalent

2.3 VIDEO SURVEILLANCE SYSTEM

A. Network Cameras
1. Provide network cameras at the locations indicated in the drawing set.
2. Camera shall have a minimum of a 3-megapixel sensor.
3. Camera shall support H.264 or H.265 compression.
4. Camera shall be equipped with a varifocal lens, with remote zoom and focus capability, and an automatic iris.
5. Exterior cameras shall be weatherproof.
6. Interior cameras shall be and vandal resistant.
7. All cameras shall include active IR.
8. Unit shall be powered using Power-over-Ethernet (PoE).
9. Exterior wall mounted cameras shall include a wall mounting bracket
   a. Basis of design: Advidia ~~A-MD-WM or A-MWM-mini~~ E-B203-WM
10. Acceptable products:
   a. Interior cameras.
      1) Advidia ~~A-37-F~~. E-37-V
      2) Approved equivalent.
   b. Exterior cameras.
      1) Advidia ~~A-37-F~~. E-37-V
      2) Approved equivalent.
11. Provide all accessories for a complete and neat installation.

B. Network Video Recorder

1. Provide Network Video Recorder (NVR) compatible with Video Insight Video Management System.
2. **If the network cameras and the NVR both include capabilities for H.265 compression, this algorithm shall be used. Otherwise H.264 shall be used.**
3. Provide sufficient storage capacity within the NVR to maintain 30 days of recording for all cameras at 15 frames per second.
4. Acceptable Products:
   a. Video Insight NVR.
   b. Approved equivalent.

2.4 ACCESS CONTROL SYSTEM

A. Access Control Processing
1. System: Access Control System shall be Identiv Velocity (existing district owned server and software.)
2. Connectivity between the server and the access control panels shall be provided over the district WAN.
3. The contractor shall be responsible for providing a complete and functional system as specified.
4. All devices required to complete the installation may not be described within this subsection but shall be provided as if specifically called for within the specification. All system components shall be approved and certified for the function they will perform.
5. The Access Control System (ACS) shall be an enterprise-class system that supports system programming, system monitoring, administrative activities, report generation, card/credential enrollment and ID badge issuance.
6. A workstation that gives a user an interface allowing the control of the local/global sites shall be provided by Contractor or Customer as agreed upon in contract documents.
7. The Contractor shall optimize existing system settings as required by system owner to support the system operation, system monitoring, credential enrollment, badge ID issuance, and record keeping.
8. Contractor / VAR shall provide end-user training to end-user satisfaction.

B. Access Control Panels (ACPs) and Cabinet Enclosures:
1. The Access Control Panels (ACPs) shall be of a distributed database design; and shall use intelligent microprocessors to make smart decisions at the Access Control Panel.
2. Acceptable product.
   a. Hirsch MX-8 Door Controller
   b. Approved equivalent.
3. Power Supply(s) and Batteries: power supply and sealed back-up batteries shall be included with the ACP.
4. Tamper switch: The cabinet shall be protected by an anti-tamper device in such a way that a tamper alarm shall be generated if any portion of any door moves more than one quarter of one inch from its closed position. This alarm shall be sent to the Monitoring Station.
5. I/O boards as required
   a. Hirsch AEB8
   b. Approved equivalent
6. Other equipment required to provide a functional, working system.

C. Power Requirements:
1. The Access Control Panels and related hardware shall be fed from an emergency power system power at 120VAC as required.
2. Lock Power Supply:
   a. The electric lock power supply shall be Von Duprin PS902-2RS at each door.

D. Proximity Readers
1. Provide proximity credential readers at each access-controlled door.
2. Reader shall be a multi-class reader capable of reading 125 KHz proximity and 13.56 MHz contactless smart cards.
3. Reader to provide audio and visual feedback of a credential read.
4. Provide mullion readers in locations with curtain walls. Provide standard width readers in all other locations.
5. Acceptable products:
   a. HID Global:
      1) ProxPoint Plus 6005

2.5 DOOR HARDWARE

A. Exit device with electric latch retraction
1. Von Duprin 98/99 with QEL option

2. Von Duprin EPT

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements and other conditions affecting the performance of the AV System. Advise Consultant of any discrepancies between field conditions and drawings that affect subject Work. Do not proceed until unsatisfactory conditions have been corrected.

B. Provide weekly status report. All concerns and issues related to maintaining the proposed schedule should be addressed in these reports. Issues that are not documented in this format will be considered the sole responsibility of the Contractor.

C. It is the Contractor's responsibility to contact the General Contractor and AV Consultant to coordinate any required data cabling installation prior to commencing any installation Work.

3.2 INSTALLATION

A. Installation shall include the delivery; unloading; setting in place; fastening to walls, floors, ceilings, counters, and other structures where required. Interconnecting wiring of the system components, equipment alignment and adjustments, and all other Work whether or not expressly required herein which is necessary to result in a complete operational system. Install system in accordance with NFPA 70 and any other National, State, and/or Local applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. During installation, and up to the date of final acceptance, the Contractor shall be under obligation to protect his finished and unfinished Work against damage and loss. In the event of any such loss or damage, the Contractor shall replace or repair such Work or equipment at no cost to Owner.

C. Install plumb and level and secured in accordance with manufacturer's instructions.

3.3 EQUIPMENT ENCLOSURES

A. Size equipment enclosures and load all equipment per equipment requirement. Contractor shall provide detailed rack elevations in the Contractor's submittal drawings.

B. Power Provisions: Install a single switch in the cabinet to supply the cabinet power distribution system. Provide electrical outlets to accommodate the AC power cords of each item of equipment. Outlets should be spaced to optimize neatness of cable runs within the rack. Number of circuits and amperage requirements for each receptacle should be sized appropriately for the equipment that will be plugged into it. In systems where new-dedicated AC power is being provided, the Contractor shall bring all unterminated circuits to a junction box within each equipment enclosure where the electrical Contractor will tie them in. The junction boxes should provide knockouts for various standard conduit sizes. For systems utilizing existing power outlets, the Contractor shall provide appropriate power distribution within the equipment enclosure terminating to an approved electrical connector and providing the necessary jacketed cabling to reach the existing power outlet.

C. Ventilation: Provide in the cabinet a low-noise fan for forced air ventilation. Equip fan with a filtered input vent and connect to operate from 105-130-V, 60 Hz electrical power, partly fused and switchable and arranged to be powered whenever the main cabinet power switch is on.

D. Equipment Rack: Mount equipment in 19-inch racks in accordance with Electronic Industries Association Standards: Group items of the same function together, either vertically or side-by-side. Arrange controls symmetrically. Make all power supply connections, AC and DC, with approved plugs and receptacles. Arrange all inputs, outputs, interconnections, and test points so they are accessible at the rear of the rack for maintenance and testing, with each item removable from the rack without disturbing other items or connections. Cover empty space in equipment racks with blank panels so that the entire front of the rack is occupied. Provide ventilated rear and side panels. Provide louvers in panels to insure adequate ventilation. Provide racks and panels with a uniform baked-enamel factory finish over rust-inhibiting primer.

3.4 GROUNDING

A. Provide equipment-grounding connections for system as indicated. Tighten connections to comply with tightening torque specified in UL Standard 486A to secure permanent and effective grounds.

B. System Grounding:
   1. Equipment: A separate 12-gauge copper insulated ground conductor shall connect the chassis of each piece of equipment to the ground buss. Connections to the buss shall be secured by machine screws at holes, which are drilled and tapped. All connections shall be properly crimped and soldered as provided elsewhere.
   2. Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground.
   3. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 0.1-ohm ground at main equipment location. Measure, record, and report ground resistance. Provide isolation transformers as necessary.
   4. Technical Grounding: All equipment within the technical power system will be grounded back to the technical reference ground using an isolated star grounding system. Technical ground is insulated and isolated from all other systems, except at the electrical connection where the master technical ground connects to the neutral bus, and ground electrode system at the service entrance equipment.

3.5 FIELD QUALITY CONTROL

A. Pre-testing: Upon completing installation of the system, align, adjust, and balance the system and perform complete pre-testing. Determine, through pre-testing, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

B. Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the systems.

C. Testing: Upon completion of pre-testing, notify the Consultant a minimum of 10 days in advance of acceptance test performance. Schedule and conduct tests in his presence. Provide a written record of test results.

D. Retesting: Rectify deficiencies indicated by tests and completely retest Work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards. Provide a written record of all retest results.

3.6 COMMISSIONING

A. Test all Audio-Video System components, in the presence of the Owner, and/or Owner Authorized Representative, for compliance with the performance standards.

B. Check all control functions, from all controlling devices to all controlled devices, for proper operation.

C. Adjust, balance, and align all equipment for optimum quality and to meet the manufacturer’s published specifications. Establish and mark normal settings for all level controls, and record these settings in the “System Operation and Maintenance Manual”.

D. Upon approval or the Contractor’s test report, and at the time set by the Consultant, demonstrate that the final system adjustments and tests meet the performance requirements. Provide all labor, materials, tools and measurement equipment for these tests and adjustments.

E. The Contractor is responsible for all costs incurred to satisfy criteria requirements.

F. Deliver “Operation and Maintenance” manuals and “Instruction Guides” to Owner.

G. Clearly label all critical settings of knobs, levers, and switches with a visible tag to signify optimal settings of all audio and video equipment.

H. Post Occupancy Adjustments: When requested by the Consultant within one (1) year of final acceptance provide up to three (3) separate, two (2) day, on-site assistance visits in adjusting sound levels and

equalizers, adjusting visual displays, control system programming additional system presets, and adjusting controls to suit actual occupied conditions.

3.7 TRAINING

A. Upon completion of any punch list items and submittal delivery, the Contractor shall coordinate with Consultant and the Owner to schedule the following training sessions:

B. One two-hour session to train end users on basic system operations in a group style format.

END OF SECTION

SECTION 28 31 00

FIRE ALARM SYSTEMS (PERFORMANCE SPECIFICATION)

PART 1 - GENERAL

1.1 DESCRIPTION OF THE WORK

A. Provide for the design and installation of the fire alarm system, with suggested minimum device coverage as indicated. Additional devices may be required for NFPA approved coverage based on conditions not known at the time of issue.

B. Provide Surge Protection Devices (SPDs) / TVSS surge suppression as required by NFPA 72 for all underground circuits. Surge protection device DITEK, devices from their fire alarm product line.

C. Required system features:

1. The fire alarm system shall comply with requirements of NFPA Standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The system shall be supervised either electrically or by software-directed polling of field devices. The system shall also be listed by Underwriter's Laboratories under the category of Control Unit System (UOJZ) and Control Unit Accessories (UOXX).
2. Multiplex communication conductors.
3. Control of auxiliary devices, such as fan shut down, etc. Battery standby system - 24 hour.
4. Remote station annunciator contacts.
5. Microprocessor based monitoring and control system. Multiplex communication conductors. (Class A)
6. Remote station annunciator, refer to drawings for location(s)
7. The system shall be 100% field programmable without the need for external computers or PROM programmers, and shall not require the replacement of memory IC's.
8. Provide integrated dialer for outside monitoring of facility. Interface to Kitchen Hood Fire Extinguishing System.
9. Interface to Fire Doors and associated release mechanisms. Door Hold Open devices and release mechanisms.
10. Provide integrated IP Fire Alarm Communicator, UL Listed for monitoring Provide Farenhyte VisorALARM PLUS IP Receiver.
11. Provide integrated UDAC for Outside Monitoring to transmit system status Monitoring Service. Emergency Communication System (ECS) voice evacuation throughout entire building. Verify all requirements with local Fire Marshal.

    a. Emergency Communication System (ECS) Sound Design:

        1) The contractor shall provide intelligible voice evacuation system for an ECS.

    b. The speaker layout of the system shall be designed and confirmed by the installer to ensure intelligibility and audibility.
    c. Intelligibility shall first be determined by ensuring that all areas in the building have the required level of audibility.
    d. The design shall incorporate speaker placement to provide intelligibility. If areas are found to require additional audible notification devices upon completion and final testing, due to audibility or intelligibility at insufficient levels, the installer shall be required to supplement audible notification devices at no additional cost to the owner.

D. System shall consist of the following components or their functional equivalents

1. Microprocessor based central processing unit.
2. Remote Annunciator Panels. (Quantity as indicated on plans)
3. Annunciator.
4. Automatic detecting devices.

5. Manual devices.
6. Alarm and warning devices.

E. Fire alarm system shall be expandable by the addition of the required modules to the basic system.

F. Each zone shall consist of not more than eight manual or automatic devices.

G. Provide elevator recall, and fireman's service in accordance with the applicable codes. Coordinate specific requirements with the elevator to be installed.

H. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

I. The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.

J. At the time of Bidding, provide unit cost for owner directed changes for the following devices:

1. At the time of Bidding, provide unit cost for owner directed changes for the following devices:
2. Smoke Detectors
3. Audio / Visual Devices
4. Visual Only Devices
5. Duct Detectors
6. Pull Stations

K. Contractor to design and provide all equipment, accessories, and materials in accordance with the contract documents to provide a complete and operating system.

L. Conduits, boxes and other raceways required for the Fire Alarm system should be provided by the Fire Alarm Contractor, as required for a compliant design, including any revisions following the approved drawings by the Fire Alarm Contractor.

M. System to be designed in accordance with all applicable codes including local ordinances, by an experienced and licensed Fire Alarm designer.

N. Building is to be designed to the code minimum but also to include the additional devices / requirements stipulated within this specification. If additional devices indicated require additional design requirements to be code compliant, that is to be taken into account during bidding and designing in order to design and build a fully compliant system.

O. Review and possible changes to design are subject to review by the local Fire Marshal (or authority having jurisdiction), up to Final Testing and Acceptance by AHJ.

P. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, analog addressable intelligent fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies and wiring as shown on the drawings and specified herein. The extent of fire alarm system work is shown on drawings and in schedules, and is hereby defined to include furnishing and installing of a system with the following sequence of operation:

1. Either manual activation of a fire alarm station or activation of an automatic initiating device energizes fire alarm signaling devices, sounding a non-coded alarm, providing zone identification at the fire alarm control panel and annunciator panels.
2. Provide DACT provisions for Outside Monitoring to transmit system status. Transmission format shall be verified with the Owner before programming. Services for Outside Monitoring by Owner under separate co Provide cellular, 4G LTE backup on IP communication.

a. Provide cellular, 4G LTE backup on IP communication.

Q. The Fire Alarm Installation Contractor shall be knowledgeable and experienced in work of a similar nature to determine the extent of the work required, and to prepare shop drawings illustrating the extent of the work to be undertaken, and to pursue the work of the Fire Alarm System installation. The contractor shall review the Architectural, Plumbing, Electrical, Mechanical and Fire Alarm Drawings to fully understand the scope of work. The contractor shall supervise, release, engage and/or monitor all devices required by Code or Local Authority whether specifically indicated on drawings or addressed in specifications. The installing contractor is responsible for meeting all required local and national codes.

R. Design Criteria – In addition to designing/providing the code required minimums, the following shall be incorporated into the design utilizing the requirements of the code regarding spacing, location, additional required coverage area, etc:

1. Heat Detectors - in addition to spaces required by code, provide at the following rooms: MDF. IDF, Electrical.
   a. Provide 212deg F heads for the elevator machine room.
2. Pull Stations – shall be located at each exterior exit location. At vestibule locations, locate strobes in the corridor, not in the vestibule.
3. Where smoke coverage is required by NFPA 72, or local authority, high volume spaces such as, Gyms, Auditorium and other high ceiling (above 18ft.) are to have FAAST (aspirated smoke detectors).
4. Fire Alarm Control Panel location – reference plans for location and coordinate exact location with the Architect/Fire Marshal prior to installation.
5. Kitchen – Heat detectors at a fixed temperature rating
6. Provide in writing any deviations from the above, both exclusion recommendations and additions, for review during submittal. Exclusions are to be reviewed and considered by the owner and design team, but not guaranteed. Possible additions required by code to accommodate the above guidelines are to be included in the base bid. Minimum standards above are to be included in the design base bid, exclusions to be considered with a credit value.

S. This section of the specification includes the final design, furnishing, installation, connection and testing of the microprocessor controlled, analog addressable intelligent fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies and wiring as specified herein. The extent of fire alarm system work required is defined to include furnishing and installing of a system with the following sequence of operation:

1. Either manual activation of a fire alarm station or activation of an automatic initiating device energizes fire alarm signaling devices, sounding a non-coded alarm, providing zone identification at the fire alarm control panel and annunciator panels.
2. Services for Outside Monitoring by Midlothian ISD under separate contract.

T. The contractor shall be an authorized provider and installer of the specified equipment, and shall be knowledgeable and experienced in work of a similar nature to determine the extent of the work required, and to prepare shop drawings illustrating the extent of the work to be undertaken, and to pursue the work of the Fire Alarm System installation. The contractor shall review the Architectural, Plumbing, Electrical, Mechanical and Fire Alarm Drawings to fully understand the scope of work. The contractor shall supervise, release, engage and/or monitor all devices required by Code or Local Authority whether specifically indicated on drawings or addressed in specifications.

U. Sub-contracting of the fire alarm system or system components is not allowed. Responding proposer shall provide approved manufacturers certification with proposal.

V. The contractor shall utilize the permanent, campus building and room identification for programming of fire alarm zones. Devices shall be labeled with building names and either room names, numbers or both as directed by the owner. Refer to the architect floor plans for permanent room names and numbers.

W. Sub-contracting of the fire alarm system or system components is not allowed. Responding proposer shall provide approved manufacturers certification with proposal.

X. Provide for the design and installation of the fire alarm system, with suggested minimum device coverage as indicated. Additional devices may be required for NFPA approved coverage based on conditions not known at the time of issue.

Y. Provide an integrated tie-in of the addressable Fire Alarm system to the Building DDC Building Control system, as follows:

1. Upon detection of smoke at any duct smoke detectors (where required by NFPA 134 or local code), provide fan shut-down for the all of the air handlers noted to have a supply drop serving that local area.
2. Fire Alarm Contractor shall coordinate all required work with the Building Automation contractor for this tie-in.

Z. Fire Alarm contractor shall provide all duct smoke detectors as shown on mechanical plans, coordinate with mechanical contractor for installation on all units scheduled to be rated at over 2000cfm.

1. Fire Alarm Contractor shall coordinate with the mechanical contractor for all required work related to air handler fan shut-down.
2. Fire Alarm Contractor shall provide all duct detector devices, enclosures to the mechanical for installation, and the mechanical contractor shall provide fan shut down.

1.2 SCOPE OF THE WORK

A. An intelligent reporting, microprocessor controlled fire detection and emergency alarm communication system shall be installed in accordance with the specifications, and all applicable codes.

B. The system shall be designed such that each signaling line circuit (SLC) shall be limited to only 80% of its total capacity used during the initial installation.

C. The FACP and peripheral devices shall be manufactured 100% by a single manufacturer (or division thereof).

D. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final check-out and to ensure the systems integrity.

E. Coordinate with District for availability and set up of monitoring telephone lines.

1.3 PERFORMANCE

A. Alarm and trouble signals shall be digitally encoded by listed electronic devices onto an NFPA Style 6 looped multiplex communication system.

B. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 6 Signaling Line Circuits.

C. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D).

D. Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y).

E. Power for initiating devices and notification appliances must be from the main fire alarm control panel to which they are connected.

F. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

G. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

H. Horn circuits and control equipment shall be arranged such that loss of any one (1) horn circuit will not cause the loss of any other horn circuit in the system.

1.4 SYSTEM OPERATION

A. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

1. The System Alarm LED shall flash.
2. A local piezo-electric signal in the control panel shall sound.
3. The 80-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
5. The audio portion of the system shall sound the proper signal to the appropriate zones.

1.5 QUALITY ASSURANCE

A. Provide fire alarm system produced by one of the following manufacturers, while meeting or exceeding the minimum performance specification included herein.

1. Honeywell – Farenhyte, Black Series, is the preferred manufacturer of the fire alarm system, acceptable equal by;

a. Other approved in writing prior to bid.

B. Provide electrical products which have been tested, listed and labeled by Underwriters Laboratories, Inc., and which comply with NEMA Standards.

C. The National Fire Protection Association publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Use current locally adopted editions of the standards.

1. No. 72A Local Protective Signaling Systems.
2. No. 72D Proprietary Protective Signaling Systems.
3. No. 72E Automatic Fire Detectors.
4. No. 90A Installation of air conditioning and ventilating systems.
5. No. 101 Life Safety Code.

D. The contractor furnishing and installing the equipment shall show satisfactory evidence with the shop drawings that they maintain stocks of replacement parts, and maintain a service department which is fully capable of maintaining the equipment.

E. Fire alarm systems shall be installed by an agent having a current certificate of registration with the State Fire Marshal's Office of the Texas State Board of Insurance, in accordance with state law. A "Fire Alarm Installation Certificate" shall be provided as required by the Office of the State Fire Marshall.

F. Warranty:

1. The Contractor shall warrant his work against defective materials and workmanship for a period of one year from the date of acceptance of the entire project, unless specific longer term is specified with Individual System Specification.
2. Neither Final Payment nor any provisions in Contract Documents shall relieve the Contractor of the responsibility for faulty materials or workmanship.
3. Contractor shall remedy any defects due thereto, and pay for any damage to other work resulting therefrom, which shall appear within a period of five years from the date of acceptance of the entire project (substantial completion).
4. The Owner shall give notice of observed defects with reasonable promptness.
5. This Guarantee shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

6. The Contractor shall include all cost within their proposal to provide a full fire alarm system, with annual re-certification prior to the beginning of the school year following the first occupancy of the building after the initial system acceptance and certification, and shall include all cost for any corrective issues related to coverage and initiation design discovered by the certification, and not previously noted as warranty items.

G. Project Record Documents:

1. The Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the Building.
2. Upon submitting request for Final Payment, Contractor shall turn over to the Architect-Engineer, for subsequent transmittal to the Owner, clean, neatly marked set of reproducible plans showing “as installed” work.
3. In addition to the above, the Contractor shall accumulate during the Job’s progress the following data, in multiple duplication (three each), prepared in 3-ring binders of sufficient size, black in color, neat in appearance and turned over to the Architect-Engineer for checking and subsequent delivery to the Owner:

    a. All warranties, guarantees and manufacturer’s direction on equipment and material covered by the Contract
    b. Approved fixture/equipment brochures
    c. Copies of approved Shop Drawings
    d. Set of operating instructions. Operating instructions shall also include recommended maintenance and seasonal changeover procedures.
    e. Any and all data and/or plans required during construction.
    f. Repair parts lists of all major items and equipment including name, address and telephone number of the local supplier or agent.
    g. The first page or pages shall have the name, addresses and telephone numbers of the following; General Contractor and all sub-contractors, Major Equipment Suppliers.

H. Training:

1. Upon completion of the work and at a time designated by the Owner’s representative, provide a formal training session for the Owner’s operating personnel to include location, operation and maintenance of all the mechanical, electrical and plumbing equipment and systems.
2. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Owner’s representative one week prior to training session.
3. At the conclusion of the instruction, obtain signatures of the attendees on each copy of the outline to signify that they have proper understanding of the operation and maintenance of the systems. Submit the signed outlines to the Owner’s representative and Engineer as a condition of final acceptance.

I. Plans and Specifications

1. The plans show diagrammatically the locations of the various lines, ducts, conduits, fixtures and equipment and the method of connecting and controlling them. It is not intended to show every connection in detail and all fittings required for a complete system.
2. The Systems shall include, but are not limited to, the items shown on the plans.
3. Exact locations of these items shall be determined by reference to the general plans and measurements of the Building and in cooperation with other Contractors, and in all instances, shall be subject to the approval of the Architect-Engineer.
4. The Architect-Engineer reserves the right to make any reasonable change in the location of any part this work without additional cost to the Owner.

J. Utilities, Locations and Elevations:

1. Locations and elevations of the various utilities within this scope of work have been obtained from the City, Owner and/or other substantially reliable sources and are offered separately from the Contract Documents, as a general guide only, without any guarantees as to the accuracy.

2. The Contractor shall examine the site, shall verify to his own satisfaction the locations, elevations and the availability / characteristics (voltage/phase/pressure/capacity) of all utilities and services required, and shall adequately inform himself as to their relation to the work; the submission of bids or proposals shall be deemed evidence thereof.
3. The Contractor shall coordinate all services with the respective Utility Company or Agency during construction; coordinate changes made by Utility Companies or Agencies to the design of the project, and coordinate with the Owner, Architect-Engineer, and Utility the scheduling of any shutdowns or delays that may occur in providing service.
4. The Contractor shall verify location / depth / direction of flow, conduct all necessary tests, inspections, coordinate with Owner's representatives and Utilities, and check for existing underground utilities before ditching / trenching / drilling.
5. The Contractor shall be responsible for repair of any cut of damaged lines or utilities he uncovers and disrupts. There are lines and utilities that may not be shown on the plans.

1.6 SUBMITTALS

A. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout and main control panel module layout, configurations and terminations.

B. Manuals:

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.
4. Approvals will be based on complete submissions of manuals together with shop drawings.

C. Software Modifications:

1. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

D. Certifications:

1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

B. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics,

physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

C. All Equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

D. The main fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution Panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.2 MAIN FIRE ALARM CONTROL PANEL AND FIRE COMMAND CENTER:

A. The main FACP Central Console shall be a Honeywell, Farenhyt Series IFP-2100 ECS, and shall contain a microprocessor based central processing unit (CPU). The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, Remote Annunciator Panels. Provide red cabinet.

B. Control Panel

1. Control Panel with Emergency Communications System

a. The fire alarm control panel (FACP) shall be the Honeywell Farenhyt Series IFP-2100ECS analog addressable fire alarm control panel and emergency communication system. The audio amplifiers shall be the Honeywell Farenhyt Series ECS-50W, ECS-125W, ECS-INT50W or ECS-DUAL50W voice evacuation units. The FACP must have a 9 amp power supply and be capable of expansion to a minimum of 384 total amps via bus connected expander modules that supervise low battery, loss off AC and loss of communication.

b. The system must contain at least one (1) Honeywell Farenhyt Series ECS-50W, ECS-125W, ECS-INT50W or ECS-DUAL-50W amplifier and shall be expandable from 50 to 2000 watts utilizing up to 15 additional amplifiers. The ECS-50W and ECS-125W amplifiers shall be capable of adding a 4 zone splitter (ECS-CE4) to distribute the audio information to different locations in the installation. The system shall have the capability of controlling up to 64 notification zones. The amplifiers must contain the capability of being remotely located through a four-wire SBUS communications circuit and a two-wire VBUS voice circuit.

c. The voice evacuation system must have the capability of downloading fifteen (15) 60 second messages and utilize DSP technology for higher audio intelligibility

d. The voice evacuation system shall be capable of operating at 25vrms or 70.7vrms (ECS-50W, ECS-INT50W and ECS-DUAL50W only) and must be field selectable at the amplifier level. Systems that require additional modules for voltage conversion shall not be accepted.

e. The FACP must have Day/Night sensitivity capabilities on detectors and be capable of supporting 159 detectors and 159 analog addressable modules and expandable to a maximum of 2,100 analog addressable points per FACP. This shall be accomplished via a maximum of 63 signaling line circuits (SLC) capable of supporting up to 159 detectors and 159 addressable module devices each. The communication protocol on the SLC loop must be digital.

f. The FACP must be capable of being networked to create a virtual system that is larger than 2,100 addressable points. The FACP network must support up to 32 FACPs on the network providing a maximum addressable point capacity of 67,200 points (2,100 x 32 = 67,200).

g. The FACP must support a minimum of eight programmable “Flexputs”. The panel must have a built in 160 character LCD annunciator with the capability of having a minimum of an additional 63 supervised remote annunciators connected in the field.

h. The FACP must have a built in UL approved IP and digital communicator with the option of adding a cellular module for communications. The communicator must allow local and remote up/downloading of system operating options, event history, and detector sensitivity data.

i. The FACP must automatically test the smoke detectors in compliance with NFPA standards to ensure that they are within listed sensitivity parameters and be listed with Underwriters Laboratories for this purpose.
j. The FACP must compensate for the accumulation of contaminants that affect detector sensitivity. The FACP must have day/night sensitivity adjustments, maintenance alert feature (differentiated from trouble condition), detector sensitivity selection, auto-programming mode (Jumpstart) and the ability to upgrade the core operating software on site or over the telephone.
k. The FACP shall have a Jumpstart feature that can automatically enroll all properly connected accessories into a functional system. Panels that do not have these capabilities will not be accepted.
l. The main communication bus (S-BUS RS485) shall be capable of class A or class B configuration with a total Bus length of 6,000 feet.

C. System Wiring

1. The Signaling Line Circuit (SLC) and data communication bus (SBUS) shall be wired with standard NEC 760 compliant wiring. No twisted, shielded or mid-capacitance wiring is required for standard installations. All FACP screw terminals shall be capable of accepting 14-18 AWG wire. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC) and also comply with article 760 of the NEC.

D. Signaling Line Circuits

1. Each SLC shall be capable of a wiring distance of 5,000 feet from the SLC driver module (6815) and be capable of supporting 159 detectors and 159 addressable module devices. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC in under 10 seconds. The auxiliary 6815 SLC loop module must be capable of being located up to 6000 feet from the FACP on an RS-485 bus, which is separate from the SLC bus. The SLC shall be capable of functioning in a class A or class B configuration.

E. SLC Loop Devices

1. Devices supported must include analog photoelectric, analog heat detectors, addressable input modules, relay output modules or addressable notification modules. There is to be no limit to the number of any particular device type up to the maximum of 159 detectors and 159 addressable modules that can be connected to the SLC.

F. Addressable Detector Functions

1. The products of combustion detectors must communicate analog values using a digital protocol to the control panel for the following functions:

a. Automatic compliance with NFPA 72 standards for detector sensitivity testing.
b. Drift compensation to assure detector is operating correctly.
c. Maintenance alert when a detector nears the trouble condition
d. Trouble alert when a detector is out of tolerance
e. Alert control panel of analog values that indicate fire.

G. Sensitivity function

1. The FACP shall have the ability to set three different sensitivity levels. A zone can be programmed to a day and a night sensitivity value. The day/night schedule shall allow for 16 holiday dates that are user programmable to allow the FACP to respond at the night level on those days.

H. Programmable Flexputs

1. The FACP shall support six (6) programmable Flexput circuits that are capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits shall also be

programmable as input circuits in Class A or Class B configurations to support dry contact or compatible two wire smoke detectors.

I. Addressable Notification Module

1. The contractor shall furnish and install where indicated on the plans, addressable notification modules, Honeywell Farenhyt Series Model SK-CONTROL. The modules shall be U.L. listed compatible with Honeywell Farenhyt Series IFP-2100ECS fire alarm control panel. The notification module must provide one class A (Style Z) or class B (Style Y) notification output with one auxiliary power input. The notification module must be suitable for mounting in a standard 4 square electrical box and must include a plastic cover plate. The notification module must provide an LED that is visible from the outside of the cover plate. The notification module must be fully programmable for such applications as required by the installation. The SK-CONTROL shall reside on the SLC loop and can be placed up to 5,000 feet from the control or 6815 SLC loop module.

J. Annunciators

1. The main control must have a built in annunciator with a 160-character LCD display and feature LED's for Alarm, Supervisory, Trouble, Silenced and Power. When in the normal condition the LCD shall display time and date based on a 200 year clock which is capable of automatic daylight savings time adjustments. All controls and programming keys are silicone mechanical type with tactile and audible feedback. Keys have a travel of .040 in. No membrane style buttons will be permissible. The annunciator must be able to silence and reset alarms. The annunciators must have twenty levels of user codes that will allow the limitation of operating system programming to authorized individuals.

K. Remote Annunciators

1. The fire system shall be capable of supporting remote annunciators. LCD Remote annunciator, Model RA-2000, shall have the same control and display layout so that they match identically the built in annunciator. Remote annunciators shall be available in two colors, red and light gray. Remote annunciators shall have the same functionality and operation as the built-in annunciator. All annunciators must have 160-character LCD displays and must feature five LED's for Alarm, Supervisory, Trouble, Silenced, and Power. All controls and programming keys are silicone mechanical type with tactical and audible feedback. Keys shall have a travel of .040 inches. No membrane style buttons will be permitted.
2. The annunciator must be able to silence and reset alarms. The annunciator must have twenty levels of user codes that will limit the operating system programming to authorized individuals. The control panel must allow all annunciators to accommodate multiple users input simultaneously. Remote annunciators shall be capable of operating at a distance of 6,000 feet from the main control panel on unshielded, non-twisted cable.

L. I/O Module

1. The fire system shall be able to support I/O modules (SK5880) that shall be used to drive remote LED graphic style displays and accommodate up to eight dry contact type switch inputs, including ECS inputs. The I/O modules shall each drive up to 40 LEDs without requiring external power connections. The I/O module inputs shall be supervised and be suitable for alarm and trouble circuits as well as reset and silence switches. The system shall also support up to 40 LED drivers that reside on the two-wire SLC loop. These driver boards shall contain 80 LED outputs that are powered by an external power source.

M. Serial/Parallel Interface

1. The fire system shall be capable of supporting up to two serial/parallel interfaces (SK5824) that are capable of driving standard computer style printers. The interface shall be programmable for the serial and parallel ports and allow printing of events as they occur.

N. Distributed Power Modules

1. The contractor shall supply power modules, Models RPS-1000 and 5496, compatible with the IFP-2100ECS fire alarm control panel. The RPS-1000 power module must have 6 amps of output power, six Flexput™ circuits rated at 3amps each, and two form C relay circuits rated at 2.5 amps at 24 volts DC. The six Flexput™ circuits shall have the same functionality as the Flexput™ circuits on the main panel. The RPS-1000 shall be capable of being connected via an RS-485 system bus (SBUS)

at a maximum distance of 6,000 feet from the main control panel. The RPS-1000 shall contain an additional RS-485 bus that is completely compatible with all IFP-2100ECS add on modules; including 6815 SLC expanders, RA-2000-SK5865-SK5880 annunciators, 5824 serial/parallel module and addressable devices. The RPS-1000 will also act as a bus repeater so that additional RS-485 (modules) devices can be connected at a maximum distance of 6,000 feet from the power module.

2. The 5496 power module must have 6 amps of output power and four circuits rated at 3 amps each. The four circuits can be programmed as notification outputs or auxiliary power outputs of door holder, constant and resettable types.

O. Digital Communicator

1. The digital/IP communicator must be an integral part of the control panel and be capable of reporting all zones or points of alarm, supervisory, and trouble as well as all system status information such as loss of AC, low battery, ground fault, loss of supervision to any remote devices with individual and distinct messages to a central station or remote station. The communicator must also be capable of up/downloading of all system programming options, event history and detector sensitivity compliance information to a PC on site or at a remote location.
2. The communicator shall transmit the information by one or more of the following means of communication – internet, cellular or standard telephone lines. The communicator must be capable of reporting via SIA and Contact ID formats. The communicator shall have a delayed AC loss report function which will provide a programmable report delay plus a 10-25 min random component to help ease traffic to the central station during a power outage. No controls that use external modems for remote programming and diagnostics shall be accepted.

P. Dry Contacts

1. The FACP will have three form “C” dry contacts, one will be dedicated to trouble conditions, the other two will be programmable for alarm, trouble, sprinkler supervisory, notification, pre-alarm, waterflow, manual pull, aux. 1 or aux. 2. The trouble contact shall be normal in an electrically energized state so that any total power loss (AC and Backup) will cause a trouble condition. In the event that the Microprocessor on the FACP fails the trouble contacts shall also indicate a trouble condition.

Q. Ground Fault Detection

1. A ground fault detection circuit, to detect positive and negative grounds on all field wiring. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground fault will not interfere with the normal operation, such as alarm, or other trouble conditions.

R. Overcurrent Protection

1. All low voltage circuits will be protected by microprocessor controlled power limiting or self-restoring poly-switches for the following: smoke detector power, main power supply, indicating appliance circuits, battery standby power and auxiliary output.

S. Test Functions

1. A Lamp Test mode shall be a standard feature of the fire alarm control panel and shall test all LEDs and the LCD display on the main panel and remote annunciators.
2. A “Walk Test” mode shall be a standard feature of the fire alarm control panel. The walk test feature shall function so that each alarm input tested will operate the associated notification appliance for two seconds. The FACP will then automatically perform a reset and confirm normal device operation. The event memory shall contain the information on the point tested, the zone tripped, the zone restore and the individual points return to normal.
3. A “Fire Drill” mode shall allow the manual testing of the fire alarm system notification circuits. The “Fire Drill” shall be capable of being controlled at the main annunciator, remote annunciators and via a remote contact input.
4. A bypass mode shall allow for any point or NAC circuit to be bypassed without effecting the operation of the total fire alarm system.

T. Remote Input Capabilities

1. The control panel shall have provisions for supervised switch inputs for the purpose of Alarm reset and Alarm and trouble restore.

U. Notification Appliance Mapping Structure

1. All notification circuits and modules shall be programmable via a mapping structure that allows for a maximum of 999 output groups. Each of these groups shall have the ability to be triggered by any of the panels 999 zones, panel wide events, or site wide events. Additionally each zone, panel, or site will individually control the cadence pattern of each of the groups that it is mapped to so that devices can indicate a variety of conditions. The zone, panel, or site shall be capable of issuing a different cadence pattern for each of the groups under its control. The mapping structure must also allow a group to be designated to “ignore cadence” for use with strobes and other continuous input devices. Zones shall have ten different output categories; Detector Alarm, Trouble, Supervisory, Pre-alarm, Waterflow, Manual Pull, Zone Auxiliary 1 and Zone Auxiliary 2, CO Alarm and CO Supervisory.
2. Each of the categories shall have the ability to control output groups with a cadence pattern. The patterns are; March code, ANSI 3.41, Single Stroke Bell Temporal, California Code, Zone 1 Coded, Zone 2 Coded, Zone 3 Coded, Zone 4 Coded, Zone 5 Coded, Zone 6 Coded, Zone 7 Coded, Zone 8 Coded, Custom Output Pattern 1, Custom Output Pattern 2, Custom Output Pattern 3, Custom Output Pattern 4, Constant, System Sensor Synchronization, Wheelock Synchronization, Gentex Synchronization, Amseco Synchronization, and Faraday Synchronization. This mapping/cadence pattern shall be supported by all system power supplies. 15 recordable one minute messages are available that can be mapped to eight ECS buttons. ECS messages can have priority over fire alarm outputs.

V. On-board Programmer

1. The FACP shall have an on board programmer which will allow for all system functions and options, except for mapping, to be programmed via the on board annunciator keypad. Any panel that does not have this capability will not be accepted.

W. Downloading Software

1. The fire alarm control panel must support up/downloading of system programming from a Windows based PC. The FACP must also be able to download the detector sensitivity test results and a 1000 event system event buffer to the PC. Communication shall take place over a direct connection to the PC and/or via the same telephone lines as the built in digital communicator and shall not require an external modem to be connected to the panel. The downloading software shall contain a code that will block unauthorized persons from accessing the panel via direct connection or over the phone lines.

X. English Language Descriptions

1. The FACP shall provide the ability to have a text description of each system device, input zone and output group on the system. The use of individual lights to provide descriptions will not be acceptable.

2.3 System Operations

A. Alarm

1. When a device indicates any alarm condition the control panel must respond within 10 seconds. The General Alarm or Supervisory Alarm LED on the annunciator(s) should light and the LCD should prompt the user as to the number of current events. The alarm information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.
2. When the alarmed device is restored to normal, the control panel shall be required to be manually reset to clear the alarm condition, except that the alarms may be silenced as programmed.
3. An alarm shall be silenced by a code at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur (subsequent alarm feature). When alarms are silenced the silenced LED on the control panel, and on any remote annunciators shall remain lit, until the alarmed device is returned to normal.

B. Trouble

1. When a device indicates a trouble condition, the control panel System Trouble LED should light and the LCD should prompt the user as to the number of current events. The trouble information must

be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.

2. When the device in trouble is restored to normal, the control panel shall be automatically reset, the trouble restore information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators. A trouble shall be silenced by a code or at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur.

C. Supervision Methods

1. Each SLC loop shall be electrically supervised for opens and ground faults in the circuit wiring, and shall be so arranged that a fault condition on any loop will not cause an alarm to sound. Additionally, every addressable device connected to the SLC will be supervised and individually identified if in a fault condition. The occurrence of any fault will light a trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.
2. Each indicating appliance circuit shall be electrically supervised for opens, grounds and short circuit faults, on the circuit wiring, and shall be so arranged that a fault condition on any indicating appliance circuit or group of circuits will not cause an alarm to sound. The occurrence of any fault will light the trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.

D. Control Unit

1. System Cabinet

a. Mounting

1) The system cabinet shall be red and can be either surface or flush mounted. The cabinet door shall be easily removable to facilitate installation and service.

E. Audible System Trouble Sounder

1. An audible system trouble sounder shall be an integral part of the control unit. Provisions shall also be provided for an optional supervised remote trouble signal.

F. Power Supply and Charger

1. The entire system shall operate on 24 VDC, filtered switch mode power supply with the rated current available of 9 Amps. The FACP must have a battery charging circuit capable of complying with either of the following requirement:

a. Sixty (60) hours of battery standby with five (5) minutes of alarm signaling at the end of this sixty (60) hour period (as required per NFPA 72 remote station signaling requirements) using rechargeable batteries with automatic charger to maintain standby gel-cell batteries in a fully charged condition.
b. Twenty-four (24) hours of battery standby with five (5) minutes of alarm signaling at the end of this twenty-four (24) hour period (as required per NFPA 72 central station signaling requirements) using rechargeable batteries with automatic charger to maintain gel-cell batteries in a fully charged condition.

2. The power supply shall comply with U.L. Standard 864 for power limiting.
3. The FACP will indicate a trouble condition if there is a loss of AC power or if the batteries are missing or of insufficient capacity to support proper system operation in the event of AC failure. A “Battery Test” will be performed automatically every minute to check the integrity of the batteries. The test must disconnect the batteries from the charging circuit and place a load on the battery to verify the battery condition.
4. In the event that it is necessary to provide additional power one or more of the Model RPS-1000 or 5496 distributed power modules shall be used to accomplish this purpose.

G. Connectors and Circuits

1. Connections to the light and power service shall be on a dedicated branch circuit in accordance with the National Fire Alarm Code NFPA 72, National Electrical Code (NEC) NFPA 70, and the local authority having jurisdiction (AHJ). The circuit and connections shall be mechanically protected.
2. A circuit disconnecting means shall be accessible only to authorized personnel and shall be clearly marked “FIRE ALARM CIRCUIT CONTROL”.

H. Accessory Components

1. The FACP shall support the following devices on the RS-485 data bus:

a.	6815	Signaling Line Circuit Expander (SLC) Module
b.	5824	Printer Interface Module
c.	RA-2000	LCD Remote Annunciator
d.	5865-3	LED Remote Annunciator
e.	5865-4	LED Remote Annunciator with reset and silence switches
f.	5880	LED I/O module
g.	RPS-1000	Intelligent Distributed Power Module Remote
h.	5495	Addressable Power Supply 6.0 Amp

2. The FACP shall support the operation of 159 detectors and 159 addressable module total devices per SLC loop without regard to device type.

I. Provide fire alarm system products in sizes and capacities indicated, complying with manufacturer's published product information on standard materials and components designed and constructed for applications indicated.

J. Provide required basic wiring materials as specified in Division 26 sections. Comply with manufacturer's instructions and recommendations.

K. Remote Paging Unit: Remote paging unit that provides a supervised microphone, 8 emergency message buttons, and 16 mappable audio switches. Provide flush mounted cabinet.

L. Speakers: Provide manufacturer's standard construction fire alarm speaker, System Sensor Spectr- Alert Advance. UL listed to Standard 1971 and shall meet the following criteria:

1. Ceiling Mount:
   a. Indoor - System Sensor SPCW(V) Dual voltage (25/70.7 Vrms) with high volume dB sound output where required for coverage.
2. Wall Mount Mount:
   a. Indoor - System Sensor SPW(V) Dual voltage (25/70.7 Vrms) with high volume dB sound output where required.
   b. Outdoor- System Sensor SPW(K) Dual voltage (25/70.7 Vrms) with high volume dB sound output where required for coverage.

M. Speaker Strobes: Provide manufacturer's standard construction fire alarm speaker / strobe, System Sensor Spectr- Alert Advance. UL listed to Standard 1971. . Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria:

1. Ceiling Mount:
   a. Indoor - System Sensor Advance Speaker Strobe SPCR Dual voltage (25/70.7 Vrms) with high volume dB sound output, and candela setting as required for coverage.
   b. Outdoor - System Sensor SPSRK Dual voltage (25/70.7 Vrms) with high volume dB sound output, and candela setting as required for coverage.

N. Strobes: Provide manufacturer's standard construction fire alarm strobe, with flashing xenon light visual signal. UL listed to Standard 1971. Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria:

1. Strobes: Provide manufacturer's standard construction fire alarm strobe, System Sensor L-Series. UL listed to Standard 1971. . Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria:
    a. Ceiling Mount:
        1) Indoor - System Sensor L-Series Strobe SCWL, Dual voltage (25/70.7 Vrms) with candela setting as required for coverage.
    b. Wall Mount:
        1) Indoor - System Sensor L-Series Strobe SRL, Dual voltage (25/70.7 Vrms) with candela setting as required for coverage.
2. The maximum pulse duration shall be 2/10 of one second.
3. Strobe intensity shall meet the requirements of UL 1971.
4. The flash rate shall meet the requirements of UL 1971.

O. Addressable Devices - General

1. Addressable devices shall provide an address-setting means using rotary decimal switches.
2. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches. Devices which use a binary address or special tools for setting the device address, such as a dip switch are not an allowable substitute.
3. Detectors shall be analog and addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.
4. Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.
5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature.
8. The following bases and auxiliary functions shall be available:
    a. Sounder base rated at 85 DBA minimum.
    b. Form-C Relay base rated 30VDC, 2.0A.
    c. Isolator base.
9. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
10. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).

P. Addressable Pull Box (Pull station): Provide manufacturer's standard construction, red enclosure, manual fire alarm stations, double action semi flush mounting, Silent Knight SK-PULL-DA, Addressable.

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75" or larger. Provide "Stopper II" with local audible alarm at each pullstation location. Provide "Weather Stopper II" with local audible alarm at exterior locations. (Verify with Each Authority Having Jurisdiction on acceptance of audible alarm on pull station covers.) Where allowed by Local Authority. Provide without audible alarm where audible alarm is not allowed.

Q. Intelligent Photoelectric Smoke Detector: Provide manufacturer's standard construction automatic photoelectric type smoke detector, Silent Knight SK Protocol type with base, SK-PHOTO-W.

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

R. Intelligent Thermal Detectors (Heat Detector)

1. Thermal detectors shall be intelligent addressable devices with absolute temperature rated at 135°F to 150°F, adjustable at the panel. It shall connect via 2 wires to the fire alarm control panel signaling line circuit, Silent Knight, SK Protocol type with base, SD505-HEAT-W.

S. Door Holders and Closers

1. Door holders, flush mounted standard hardware depth. Silent Knight FM998-120 or equal. Refer to electrical drawings for additional information and mounting locations.

T. Intelligent Duct Smoke Detector: (Duct Detector) Provide manufacturer's standard construction automatic smoke detectors, duct type, with sampling tubes, Silent Knight SK Protocol type, SD505-DUCTR with SD505-PHOTO-W smoke detector and housing, with auxiliary contacts for fan shut down as required. (Provided and installed by Fire Alarm Contractor, Addressable Device.)

1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. Duct detectors located above ceiling level shall have device labeled alarm LED test/reset switch in ceiling below detector and clearly readable from floor level. Provide with manufacturers optional accessory remote test/reset for ceiling mount, SD505-DTS-K.
3. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

U. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops. Silent Knight SK-MONITOR or SK-MINIMION.
2. The monitor module shall mount in a 4" square, 2" deep electrical box.
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2" x 1-3" x 2". This version need not include Style D or an LED.

V. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay. Silent Knight SK-CONTROL.
2. The control module shall mount in a standard 4" square, 2" deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (FormC) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

W. Isolator Module

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each floor or protected zone of the building. Silent Knight SK-ISO.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall mount in a standard 4" deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

X. Remote Power Supplies

1. The remote power supplies for notification appliances shall be the Model SK- 5495. The Model RPS-1000 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-2100ECS. It will support 6 amps of 24 volt DC power with 8 Flexput™ circuits, rated at 3 amps each. Two additional 6815 SLC loop expanders shall be capable of be install in the cabinet. The power supply will also regenerate the SBUS for an additional 6000 feet of SBUS capability.
2. The 5495 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-2100ECS. It will support 6 amps of 24 volt DC power with 4 notification circuits, rated at 3 amps each.
3. The remote power supply model 5499 or 5495 may also be used on the system. These power supplies are activated by a notification circuit or an SK-Protocol control module and support 6 or 9 amps of 24VDC power, with 4 notification circuits, rated at 3amps each.

Y. Intelligent Isolator Base

1. Fully supervised, tamper-proof isolator base for SK Series detectors. SK Protocol type, B224BI.

Z. Intelligent Fault Isolator Module

1. Addressable line isolator module, SK Protocol SK-ISO.

AA. Intelligent Relay Module

1. Addressable relay module, with rotary address switches, and two sets of From C contacts. SK-Relay.

BB. Intelligent Notification Module

1. Addressable notification module, with rotary address switches. SK-Control.

CC. Intelligent Monitor Module

1. Addressable notification module, with rotary address switches. SK-Monitor.

DD. Door Holders and Closers:

1. Door holders, flush mounted standard hardware depth. Silent Knight FM998-120 or equal. Refer to electrical drawings for additional information and mounting locations.

EE. Cable

1. Provide cable color jacket for the following system circuits as noted below:
    a. SLC – Red.
    b. NAC – Red with Yellow trace.
    c. IDC – Red.
    d. Speaker – Red with Blue trace.
    e. Auxiliary power – Red with Yellow trace.
    f. SYNC wire – Black.

FF. System Record Document Cabinet

1. Provide wall mounted Fire Alarm record document cabinet, (1) per campus, exact location to verified with owner prior to installation. Cabinet to be constructed of 16ga. Steel, with a solid piano hinge for the door, and key lock. Provide with 4GB USB flash drive (or adequate size required for storage of all related documents, and software) equal to SRD ACE-11, by Space Age Electronics. Provide with custom project lettering with the District name & logo, and campus name, and lock keyed to the fire alarm control panel.

2.4 BATTERIES AND EXTERNAL CHARGER

A. Battery:

1. Shall be 12 volt, Gell-Cell type.
2. Battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus 5 minutes of alarm upon a normal AC power failure.
3. The batteries are to be completely maintenance free.
4. Final battery size to be calculated & confirmed by system installer based on actual system loads.
5. External, physical dimension shall allow for placement within system enclosure.

B. External Battery Charger

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120-volt 60 hertz source.
2. Shall be rated for fully charging a completely discharged battery within 60 hours while simultaneously supplying any loads connected to the battery.
3. Shall have protection to prevent discharge through the charger.
4. Shall have protection for overloads and short circuits on both AC and DC sides.
5. Final battery charger characteristics to be calculated & confirmed by system installer based on actual system loads.

C. Microprocessor based monitoring and control system

1. The monitoring and control system shall consist of a central processing unit, (CPU), Display Interface Assembly DIA, Remote Annunciator Panels. The system shall be of modular construction, with components connected together using multiplex wiring techniques to provide Fire Detection and Evacuation signals. System shall be Silent Knight IFP-1000 ESC Intelligent, Addressable, and Analog Multiplex Life Alarm or approved equal. CPU shall be surface or flush wall mounted control units where shown. Unit shall have all necessary components to completely supervise and operate the system. Power wiring shall be for single phase operation. Unit shall include the following functional equivalents, as required:

   a. Zone modules.
   b. Power supplies.
   c. Emergency battery for 60 hour backup.
   d. Battery charging circuit.
   e. Auxiliary relays.
   f. Common module.
   g. Controls: System reset, acknowledge, lamp test, trouble, silence.
   h. Indicators: Common alarm, common trouble, AC power failure, low battery, and power on.
   i. Other equipment and components as required for system operation.

2. System shall provide LCD annunciation to indicate system monitor point status, and toggle switches to allow operation of the system control points. Unit shall function as a zone annunciator and control center to initiate alarm or building evacuation function. Control center and Remote Annunciator shall be wall mounted, located as shown, with battery backup, self-contained power supply supplied by 120 volt emergency power if available or by dedicated 120 volt normal power circuit.

D. Provide fire alarm system products in sizes and capacities indicated, complying with manufacturer's published product information on standard materials and components designed and constructed for applications indicated.

E. Provide required basic wiring materials as specified in Division 26 sections. Comply with manufacturer's instructions and recommendations.

F. Tamper switches and water flow alarms, when furnished with sprinkler system, shall be connected to Fire Alarm System.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install system and materials in accordance with manufacturer's instructions and roughing in drawings, and details on the drawings. Install electrical work and use electrical products complying with requirements of applicable Division 16 sections of these specifications.

B. The term "wiring" is defined to include the providing of wire, conduit and miscellaneous materials as required for mounting and connecting the electrical devices. All wiring and devices shall be fully concealed unless otherwise approved by Engineer.

C. Install a complete wiring system as required by the local authority for fire alarm system conductor shall be two twisted pair fire alarm cable in a separate conduit system. Provide multi- conductor instrument harness bundle in place of single conductors where a number of conductors can be run along a common path. Fasten flexible conductors bridging cabinets and doors neatly along hinge side, and protect against abrasion. Tie and support conductors neatly. All cables not enclosed in raceway, shall be bundled with Velcro, and supported with J-hooks, and/or bridle rings.

D. Install a flashing lights and speakers where required by the Local Authority Having Jurisdiction.

E. Manual stations are to be set 48" above finished floor. Alarm devices are to be set at 80" aff maximum. Alarm devices in Activity rooms, Gymnasiums and other similar use areas shall be suitably protected with substantial wire guards, not less than 11 gauge, and 1" x 2" mesh.

F. Identification of individual detectors is required. All devices, including notification appliances shall be labeled with applicable circuit identification number. Identification labels must be printed labels with black lettering on a clear background. Labels must be machine printed, self-adhered and of sufficient font size to be clearly readable from the floor level. Handwritten labels or labels made from embossed tape are not acceptable.

G. Number code or color code conductors, appropriately and permanently for identification and servicing of system.

H. Provide duct detectors in air handling equipment. Fire Alarm contractor will need to coordinate with the mechanical contractor for final tie-in and set-up.

3.2 CONNECTIONS

A. The Contractor shall make provisions for and shall connect initiating devices to the Fire Alarm System which may be furnished under other sections of these specifications, whether specifically indicated on the Electrical Series drawings or not. This Contractor shall furnish wiring, make final connections to auxiliary devices furnished under other sections of the specifications, and provide interface devices such as relays where required, some of these components may be outside buildings:

1. Door Hold Open devices.
2. Fire Door release devices.
3. Duct detectors.
4. Kitchen hood fire extinguishing equipment.
5. Other dry or wet sprinkler system initiating devices.

B. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

C. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

D. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

3.3 TYPICAL OPERATION

A. Actuation of any manual station, smoke detector, heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

1. Activate all programmed horn circuits.
2. Actuate strobe units until the panel is reset.
3. Light the associated indicators corresponding to active horn circuits.
4. Release all magnetic door holders, Stage Draft doors and Fire doors to adjacent zones on the floor from which the alarm was initiated.
5. Return all elevators to the primary or alternate floor of egress.
6. A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.
7. Smoke detectors in the elevator machine room or top of hoistway shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.
8. Duct type smoke detectors shall, in addition to the above functions, shut down the ventilation system or close associated control dampers as appropriate.
9. Activation of any sprinkler system low pressure switch, on valve tamper switch, shall cause a system supervisory alarm indication.

3.4 TEST

A. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
3. Verify activation of all flow switches.
4. Open initiating device circuits and verify that the trouble signal actuates.
5. Open signaling line circuits and verify that the trouble signal actuates.
6. Open and short notification appliance circuits and verify that trouble signal actuates.
7. Ground initiating device circuits and verify response of trouble signals.
8. Ground signaling line circuits and verify response of trouble signals.
9. Ground notification appliance circuits and verify response of trouble signals.
10. Check installation, supervision, and operation of all intelligent smoke detectors using walk test.
11. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

B. The entire fire alarm system shall be tested in accordance with NFPA standards and other applicable standards. Results of such testing shall be recorded on forms approved for the purpose, certified and submitted to the Owner's representative with final documents.

3.5 RECORD DOCUMENTS

A. Provide system map of the complete fire alarm system, on full size, laminated sheets, enclosed in frames, to be mounted in location as directed by the owner. FACP program shall match map labels.

3.6 FINAL INSPECTION

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.7 INSTRUCTION

A. Provide instruction as required for operating the system. "Hands-on" demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

3.8 ZONES

A. Zones shall be identified and scheduled on the Shop Drawing Submittal using current building designations, room names and numbers.

END OF SECTION

SECTION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Section Includes:
1. Excavating, filling, backfilling, grading, and compacting of earth at the site.
2. Preparation of building pad to limits shown on plans.
3. Provide and stockpile topsoil on site.
4. Dewatering excavations.

B. Related Sections:
1. Section 01 45 23 – Testing and Inspection Services
2. Section 31 10 00 - Site Clearing

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM D 698-78 Tests Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb. Hammer and 12-in. Drop.
2. ANSI/ASTM D2922 - Density of Soil in Place by the Nuclear Methods.

1.04 SUBMITTALS

A. Submit in accordance with SECTION 01 33 23 - SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Samples: Submit a one gallon sample and material analysis results of imported topsoil from a testing laboratory indicating compliance with these specifications. Any topsoil delivered to the site which does not comply with the approved sample shall be re-tested at the Contractor's expense and replaced.

C. Test Reports:
1. Submit copies of test reports in accordance with SECTION 01 45 23 - TESTING AND INSPECTION SERVICES.
2. Compaction Tests: Submit copies of compaction test reports.

1.05 QUALITY ASSURANCE

A. Laboratory Control: On site or Imported topsoil, if required, shall be inspected and tested by an independent testing laboratory.
1. Testing laboratory shall make tests of the soil from the selected source to determine that it meets the specified requirements for select fill and imported topsoil.

1.06 PROJECT CONDITIONS

A. Temporary Sheeting: Shore and sheet excavations to protect utilities and to prevent cave-in. Maintain sheeting secure until permanent construction is in place. Remove sheeting as excavations are backfilled.

B. Drainage: Provide for adequate surface drainage during construction to keep the site free of surface water without creating a nuisance in adjacent areas.

C. Pumping: Keep the excavations free of water at all times by pumping or other means. This shall be the responsibility of the Contractor regardless of the cause, source, or nature of the water.

D. Protection:
   1. Property: Protect adjoining property, including improvements out-side the limits of the work. Protect walks, curbs, and paving from damage by heavy equipment and trucks.
   2. Protect benchmarks.
   3. Protect above and below grade utilities which are to remain.
   4. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation. Monitor shoring system and surrounding ground surface during construction to detect movement. If movement becomes significant, take contingency steps to brace excavation and adjacent utility lines.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Topsoil

   1. Strip topsoil from limits of grading areas, clean of grass, roots, rock and debris to a depth of 12”, and stockpile for placement on all landscape and “open space” areas. Contractor shall investigate the site to his satisfaction to determine if suitable material is available on site to meet the specification for topsoil.
   2. Refer to landscape architect plans and specifications for additional topsoil requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Establish extent of excavation by area and elevation; designate and identify datum elevation.

B. Set required lines and grades using a licensed surveyor.

C. Maintain bench marks, monuments and other reference points.

3.02 PREPARATION

A. Before starting excavation, establish location and extent of underground utilities occurring in work area.

B. Notify utility companies sufficiently in advance to remove and relocate lines which are in way of excavation.

C. Maintain, reroute or extend as required, existing utility lines to remain which pass through work area.

D. Protect and support utility services uncovered by excavation.

E. Remove abandoned utility service lines from areas of excavation; cap, plug or seal such lines and identify at grade.

F. Accurately locate and record abandoned and active utility lines rerouted or extended on Project Record Documents.

G. Upon discovery of unknown utility or concealed condition, discontinue affected work and notify Architect.

H. Remove grass, weeds, roots and other vegetation from areas to be excavated, filled and graded. Fill stump holes and like small excavations with suitable material placed in lifts and thoroughly tamped.

I. Scarify the subgrade soil of pavement areas to a minimum depth of 6 inches, water and recompact. Compact to at least 95% Standard Proctor in accordance with ASTM D698 (Standard Proctor), at a moisture content at or above the soil's optimum moisture content.

J. Scarify general subgrade soils in place to a depth of 6 inches and compact to at least 95% Standard Proctor in accordance with ASTM D698 (Standard Proctor), at a moisture content at or above the soil's optimum moisture content.

3.03 EXCAVATION

A. General: Excavate to the lines, grades and sections shown on the drawings. Allow space for the construction of forms. **All excavation shall be unclassified as required regardless of the condition or type of material encountered, including rock.**
   1. Cut areas accurately to the indicated cross-sections and grades. Take care to prevent excavation below the grades indicated. Any bottoms and slopes that are undercut shall be backfilled with earth fill and compacted.
   2. Finish the excavating required for graded areas and building pad to a tolerance of one inch above or below the rough grade.
   3. Remove underground obstructions except for piping and conduit which shall be handled as specified in SECTION 01 11 00 - SUMMARY OF WORK.

B. Over cut planting and lawn areas to allow a layer of topsoil not less than 8" thick.

C. Maintain excavations to drain and be free of excess water. Ponding of water on site will not be permitted.

D. Exercise extreme care in grading around existing trees. Do not disturb existing grades around existing trees except as otherwise noted. When excavation through roots is necessary, and after review by Landscape Architect, perform by hand and cut roots with sharp axe, prune trees to compensate for root loss.

E. Fill over-excavated areas under structure bearing surfaces in accordance with Architect's direction.

F. Do not allow construction equipment to create "pumping" of soils.

G. Stockpile excavated clean fill for reuse where directed. Remove excess or unsuitable excavated fill from site.

H. Over excavate existing soils in saturated conditions. Stockpile wet material. Allow drying out to take place. Mix stockpiled materials with relatively dry onsite material before recompacting.

3.04 WASTING

A. Surplus excavated material not suitable or required for embankment fill and backfill shall be wasted off site.

3.05 FILL AND BACKFILL

A. Filling: Construct compacted fills to the lines, grades and sections shown on the drawings.
   1. Complete stripping and wasting operations in advance of fill construction. Proof roll, compact, and establish moisture content.
   2. Deposit and mix fill material in horizontal layers not more than 8" deep, loose measurement. Manipulate each layer until the material is uniformly mixed and pulverized.
   3. Fill material shall have moisture content to at least +3 percentage points above its optimum moisture content and compacted to a range between 93% and 98% Standard Proctor (ASTM

D698), to achieve specified compaction. If fill is too wet, dry by aeration to achieve desired moisture content. If fill is too dry, add water and mix in by blading and discing to achieve desired moisture content.

4 Exercise care to prevent movement or breakage of walls, trenches, and pipe during filling and compaction. Place fill near such items by means of light equipment and tamp with pneumatic or hand tampers.

5. Proof roll exposed subgrade in building and paving areas with heavily loaded dump truck (25 ton minimum) or similar acceptable construction equipment, to detect unsuitable soil conditions. Commence proof rolling operations after a suitable period of dry weather to avoid degrading acceptable subgrade surfaces. Make four passes over each section with proof rolling equipment, with the last two perpendicular to the first two.
6. Cut out soft areas of subgrade not readily capable of in- situ compaction. Backfill and compact to density equal to requirements for subsequent backfill material.

B. Backfilling: Construct compacted fill against and around concrete beams below finish grade.
1. Verify areas to be backfilled are free of debris, snow, ice or water, and ground surfaces are not frozen.
2. Do not backfill until underground construction has been inspected, tested and approved, forms removed, and the excavations cleaned of trash and debris.
3. Bring backfill to required grades by depositing material in horizontal layers not more than 10" deep, loose measurement.
4. Site backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet or spongy subgrade surfaces.
5. Maintain optimum moisture content of backfill materials to attain required compaction density.
6. Make gradual changes in grade. Blend slopes into level areas.

3.06 COMPACTION

A. Compact each layer of earth fill and backfill to the compaction and density specified.
1. Scarify the subgrade soil of pavement areas to a minimum depth of 6 inches, water and recompact. Compact to at least 95% Standard Proctor in accordance with ASTM D698 (Standard Proctor), at a moisture content at or above the soil's optimum moisture content. Scarify general subgrade soils in place to a depth of 6 inches and compact to at least 95% Standard Proctor in accordance with ASTM D698 (Standard Proctor), at a moisture content at or above the soil's optimum moisture content.
2. Equipment for compacting shall be sheeps foot and rubber tired rollers or other compactors capable of obtaining the required density. Compact the fill with power tampers and by hand in areas not accessible to rollers.
3. Compact each layer of fill to the density listed below as a function of the location. The required density in each case is indicated as a percentage of the maximum dry unit weight determined using the standard compaction test ASTM D 698.
   a. Material under paving----------95%
   b. Material under lawn areas----------95%
   c. Material under building----------Per Geotechnical Report

3.07 GRADING

A. Site Grading: Shape and finish earthwork to bring the site to the finish grades and elevations shown on the drawings.
1. Establish grades by means of grade stakes placed at corners of units, at abrupt changes of grade, and elsewhere as may be required.
2. Rough grade for paving, and site improvements to the subgrade elevations required. Soft and unstable material which will not readily compact when rolled or tamped shall be removed and the resulting depressions filled with stable material and re-compacted.
3. Finish grade to the finish contours and spot grades shown. Extend cuts and fills to feather out beyond the last finish contour or spot grade shown. Grade to uniform levels and slopes between points for which elevations are given, round off abrupt changes in elevation, and finish off smoothly. Finish grades shall slope away from the building in all directions to assure proper drainage.

4. Execute erosion control measures in accordance with the Erosion Control Plan.

B. Grading Around Trees: Where grading is required within the branch spread of trees that are to remain, perform the work as follows:
   1. When trenching occurs, the tree roots shall not be cut but the trench shall be tunneled under or around the roots by hand digging.
   2. When the existing grade at a tree is below the new finished grade, and fill not exceeding 6" is required, clean washed gravel graded from 1" to 2" size shall be placed directly around the tree trunk. The gravel shall extend out from trunk on all sides a minimum of 18" and finish approximately 2" above the finished grade at the tree. Install gravel before earth fill is placed.
   3. Trees in areas where the new finished grade is to be lowered shall have re-grading work done by hand to elevation as indicated. Existing grades immediately surrounding the trunk shall not be altered except at the direction of the Architect.

3.08 PROTECTION, CLEAN-UP AND EXCESS MATERIALS

A. Protect grades from construction and weather damage, washing, erosion and rutting, and repair such damage that occurs.

B. Correct any settlement below established grades to prevent ponding of water.

C. At locations where concrete or other foreign matter has penetrated or been mixed with earth, remove damaged earth and replace with clean material.

D. Remove excess stockpiled material, debris, waste, and other material from site and leave work in clean finished condition for final acceptance. Contractor is responsible for disposal of debris and excess materials.

3.09 FIELD QUALITY CONTROL

A. Compaction Tests: Field density testing of the select fill material under the building pad and paving shall be performed by an Independent Testing Laboratory.
   1. Testing laboratory shall make one in place density test for each 5000 sq. ft. of area per lift in general site areas, but in no case less than two tests to ensure that the specified density is obtained. For tennis courts, ball fields, track, practice fields and competition field, the testing laboratory shall make one in place density test for each 3000 sq. ft. of area per lift, but in no case less than three tests to ensure that the specified density is obtained.
   4. The cost of the full-time inspection service shall be per Specification SECTION 01 45 23 - TESTING AND INSPECTION SERVICES.

3.10 CONSTRUCTION STAKING

A. All drives must be staked using the profiles provided in the plans in addition to the grading and dimensional control plans. The contractor shall stake all vertical curves and points of grade break in order to achieve a smooth and uniform grade throughout. Verify all grades and elevations to confirm that ADA parking spaces, walks and ramps are per plans.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supply General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Section Includes: Clearing the site of vegetation, site improvements and obstructions to make way for new work.

B. Related Sections
1. Section 31 00 00 - Earthwork.

1.03 PROJECT CONDITIONS

A. Existing Conditions: Site is generally vacant, covered with some trees and native vegetation. Contractor shall visit the site and verify the nature and extent of clearing work required.

B. Protection: Contractor shall be responsible for the protection of adjoining property and improvements outside the limits of the work. Protect paving and utilities from damage by equipment and trucks.

C. It shall be the responsibility of the Contractor to obtain a temporary water meter and temporary sanitary sewer facilities for use during construction.

D. Contractor shall exercise care during operations to confine dust to the immediate work area and shall employ dust control measures to ensure adequate dust control throughout demolition and construction operations.

1.04 REGULATORY REQUIREMENTS

A. Conform to applicable building code for disposal of debris.

B. Coordinate clearing Work with previous owner and utility companies.

C. Conform to applicable portions of OSHA, including 1926.604.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that existing plant life and features designated to remain are tagged or identified

B. Locate and identify all paving and utilities intended to remain. Contractor shall field verify and coordinate with Owner and respective facility owner the location and depth of existing active facilities/ utility lines within the construction limits and shall protect all such facilities from damage during

construction operations. Damage to existing facilities to remain shall be repaired at the Contractor's expense for re-establishing the facilities to their pre-damaged condition.

3.02 PERFORMANCE

A. Clearing:
   1. Remove trees, shrubs and other vegetation from within the area of the site where new construction is to be placed. Grub out roots to a depth of at least 18 inches below natural grade
   2. Dig out and remove buried obstructions to a depth of 24 inches below natural grade or 24 inches below the intended excavation elevation, whichever is lower. (Refer to landscape architect's plans and specifications)
   3. Remove existing trash, debris and abandoned facilities, which are to be removed from the site.
   4. Refer to SECTION 01 11 00 - SUMMARY OF WORK for handling of piping and conduit encountered below grade.
   5. Clear undergrowth and deadwood, without disturbing subsoil.
   6. Burning debris on site is not permitted.
   7. Remove debris, rock, fences, and extracted plant life from site.

B. Reference landscape plans and specifications for limits for tree removal and pruning/trimming limits.

B. Disposal:
   1. Clean up and remove from the site the stumps, logs, broken paving, rubble and debris resulting from the clearing and grubbing operations.
   2. Remove all traces of demolished items from the site work area and rough grade all areas that have been disturbed.
   3. Material to be wasted shall be legally disposed of off site, at no additional cost to Owner.
   4. Burning of combustible materials on the site will not be permitted.

3.03 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or regraded.

B. Stockpile in a preapproved area on or near the site. Install erosion control around perimeter of stockpile.

C. Reference landscape architectural plans and specifications for additional top soil requirements.

END OF SECTION

SECTION 31 23 03

EXCAVATION AND FILL FOR BUILDING PAD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. The section applies to earth-supported building pads and other paving indicated on the drawings to receive “Building Pad Preparation”.
   2. The section includes materials, labor and equipment required for complete installation of building pad including but not limited to: excavation, scarification and re-compaction of soils, moisturizing of soil, engineered fill material, lime and water injection, backfilling and compaction of soil, and installation of vapor retarder under slabs.
   3. Testing for moisture content of soils, plasticity index of engineered fill, and compaction.

B. Section excludes – see other sections for:
   1. Clearing and grubbing of site
   2. Mass excavation and rough grading
   3. Final grading of site
   4. Backfill around grade beams and basement walls
   5. Utility trench backfill within the building pad
   6. Laboratory testing and inspection

1.2 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
   2. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   3. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   4. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
   5. ASTM D 2488 - Standard Practice of Description and Identification of Soils (Visual-Manual Procedure).
   6. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Method (Shallow Depth).
   7. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
   8. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

B. Texas Department of Transportation: TxDOT - 2004 Standard Specifications for Construction of Highways, Streets and Bridges.

1.3 SYSTEM DESCRIPTION

A. Building pad preparation shall be as described in the Project Geotechnical Report, utilizing the following method(s):
   1. Removal and Replacement of Soil
      a. Remove all native soils to the top of tan weathered limestone.
      b. Backfill excavation with select fill or flexible base material.
      c. Place additional select fill or flexible base as required to achieve final grades.
      d. Extend removal and replacement process 5 ft outside of building pad perimeter. Do not extent select fill or flexible base beyond outside edge of the building pad. Use clay backfill around and beyond the building perimeter in the upper 2 ft to limit potential for surface water infiltration.
   2. Limestone exposed at base of any building excavation will not require reworking.

B. Recommendations and specifications of the Project Geotechnical Report are based on soil borings taken at discreet locations. No representation is made or implied regarding continuity of conditions between

borings. Additional soil borings may be made at Contractor's expense and option to verify subsoil conditions.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Contractor performing building-pad preparation work shall have at least three years' collective experience with the specific method of preparation required, and under similar circumstances.
   2. Upon request, demonstrate to the satisfaction of the Architect the dependability of the systems, materials and techniques to be used by experience, example or test.

B. Pre-construction Conference
   1. Contractor shall arrange a conference to include the Architect, Engineer, Owner and Owner's Testing Laboratory, and all sub-contractors involved in the installation of building pads before construction to demonstrate the suitability of the system and equipment.

1.5 PROJECT AND SITE CONDITIONS

A. Existing conditions: Contractor is responsible for locating and protecting existing underground utilities and building foundations.

B. Contractor shall inspect the site for conditions that may adversely affect installation of required building pads and report to the Architect before commencing work.

C. Contractor shall be thoroughly familiar with the Project Geotechnical Report.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of building pads with excavation, installation and removal of utilities and other site-related activities.

1.7 SUBMITTALS

A. Product data
   1. Submit manufacturers' descriptive literature, specifications and installation instructions for each manufactured product.

B. Samples
   1. Submit samples of fill materials in sufficient quantity for laboratory testing at least 3 business days prior to commencing fill operations.

C. Testing and Inspection reports
   1. Submit copies of required laboratory reports for compaction, moisture content, and soil characteristics.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. On site clay
   1. Free of rock fragments greater than 4", organic matter, and other deleterious materials.
   2. Avoid excessive large-size clay clods.
   3. Moisture content at least 3% above optimum moisture content.

B. Imported select fill
   1. Liquid limit of 35 or less
   2. Plasticity Index between 5 and 15
   3. Percentage passing No. 4 sieve is 100%
   4. Percentage passing No. 200 sieve is between 35% and 55%
   5. Moisture content at or above optimum moisture content

C. Flexible base material
   1. Meet requirements of TxDOT Item 247 Grade 1 or 2
   2. Crushed concrete or processed limestone meeting gradation requirements
   3. Moisture content at or above optimum moisture content

2.2 MANUFACTURED PRODUCTS

A. Vapor Retarder
   1. Polyethylene sheeting- reference Spec Section 07 26 00.

PART 3 -

3.1 EXAMINATION

A. Verify and identify required lines, levels, contours and benchmark elevations.

B. Locate and identify underground utilities.

C. Notify Architect of unexpected subsurface conditions.

D. Verify that excavations are in proper condition before placing fill material.

E. Locate and document limits of excavation.

F. Geotechnical Engineer to evaluate soundness and quality of excavations prior to fill operations.

3.2 PREPARATION

A. Protection:
   1. Protect benchmarks and existing structures to remain from excavation equipment and vehicular traffic.
   2. Protect plant life, lawns, rock outcroppings, and other features remaining as a portion of final landscaping.
   3. Protect excavations from rain and from drying out when construction has been delayed, cave-ins or loose soil from falling into excavations, and from freezing.
   4. Provide barricades, warning signs, lights, and other items at open excavations to comply with governmental regulations.
   5. Maintain and protect above and below grade utilities to remain.

B. Surface Preparation:
   1. Notify utility companies to remove and relocate existing utilities.
   2. Correct irregularities in substrate gradient and elevation by scarifying, reshaping and re-compacting.
   3. Compact excavation surface material to density requirement for backfill materials.
   4. Where required by section 1.3, scarify and re-compact the excavation surface.

3.3 EARTHWORK

A. Excavation
   1. Excavate to top of tan weathered limestone. Extend excavation a minimum of 5 feet beyond general outline of the pad.
   2. Excavations shall not infringe on stress cones under existing foundations extending along a 45-degree line from the bottom of any footing.

B. Stockpiling
   1. Stockpile excavated material on site for use as general site fill.
      a. Do not pile soil within the drip line of trees to remain.
      b. Locate and retain stockpile away from the edges of excavations.
      c. Protect stockpile from erosion.
      d. Dispose of excess excavated materials and materials not suitable for reuse off site premises.

C. Excavation stability
   1. Slope sides of excavation to comply with governmental regulations.
      a. Maintain sides and slopes of excavation in safe condition.
   2. Provide shoring and bracing where sloping is not possible or suitable.

D. Proof Rolling
   1. Where required by the Geotechnical Report, proof roll site or excavated subgrade using a pneumatic-tired roller weighing approximately 25 tons.

E. Backfilling
   1. Before backfilling, check and prepare subgrade:
      a. Remove ice, snow or standing water
      b. Remove debris and trash
      c. Verify proper subgrade elevation(s)
      d. Remove rocks, boulders and loose soil
   2. Backfill under slabs with required materials to subslab elevation.
      a. Backfill with select fill or flexible base in 8” lifts, compact to minimum 98% of maximum dry unit weight, and confirm moisture content at or above optimum moisture content as determined from the results of Standard Proctor Method (ASTM D698).
      b. Outside of the building perimeter, compact clay at upper 2 feet to minimum 94% of maximum dry unit weight and confirm moisture content 3% above optimum moisture content as determined from the results of Standard Proctor Method (ASTM D698).
      c. Do not attempt to place backfill during rain, snow, or sleet.
      d. Do not place fill material on frozen ground.

F. Moisture control and protection
   1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to required density.
   2. Protect and maintain moisture content of subgrade until placement of slabs.
      a. Regularly sprinkle water during dry and windy days.

3.4 INSTALLATION OF VAPOR RETARDER

A. See Specification Section 07 26 00.

3.5 FIELD QUALITY CONTROL

A. Inspection Services: an independent testing agency shall perform the following inspection services:
   1. Inspect stockpiles of excavated material for reuse
   2. Inspect engineered backfill material for suitability
   3. Observe backfilling and compacting procedures
   4. Observe proof rolling process
   5. Inspect condition of subgrade before commencing backfill

B. Laboratory Testing
   1. Test each lift of backfill for moisture content and compaction before subsequent lifts are placed.
      a. Perform field density tests in accordance with ASTM D698, D3017, D2922 or D4318
      b. Perform one density test for each 2,500 square feet of surface area, or at least 2 tests per lift.
      c. Perform additional tests until required density and moisture content are achieved.
   2. Test engineered fill material for soil characteristics (moisture content, plasticity index).

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Work Included:
1. Excavation for piped utility material.
2. Provide necessary sheeting, shoring, and bracing.
3. Comply with Federal, State, and local trench safety requirements.
4. Prepare trench bottom with appropriate materials.
5. Dewater excavation as required.
6. Place and compact granular beds, as required, and backfill.

B. Related Work Specified in Other Sections
1. Section 31 10 00 – Site Clearing
2. Section 31 00 00 – Earthwork
3. Section 33 10 00 – Water Utilities
4. Section 33 30 00 – Sanitary Sewerage Utilities
5. Section 33 40 00 – Storm Drainage Utilities

1.03 PRECAUTIONS

A. Contractor shall determine the exact location of all utilities prior to construction.

B. Notify all utility companies when necessary to disturb existing facilities and abide by their requirements for repairing and replacing.

C. Protect all vegetation and other features to remain.

D. Protect all benchmarks and survey points.

1.04 COORDINATION

A. Where the specifications conflict with the City Water and Sewer Specification and City Standard Details for water and sewer construction, the City Details and Specifications shall govern in that order.

PART 2 - PRODUCTS

2.01 BEDDING AND BACKFILL MATERIALS (ASTM D2487)

A. Reference Sitework Details and City Standard Specifications. Reference site drainage plan and NCTCOG Specification for storm drainage.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install barriers and other devices to protect areas adjacent to construction and to provide for public safety.

B. Protect and maintain all bench marks and other survey points.

3.02 EXCAVATION TRENCHES

A. Perform in such a manner as to form a suitable trench in which to place the pipe and so as to cause the least inconvenience to the public.

B. Maximum width at the crown of the pipe shall be sixteen (16") inches plus the bell diameter of the pipe, unless approved specifically by the engineer due to unusual bracing and shoring requirements. The minimum width at the crown at the pipe shall be one foot plus the pipe bell diameter.

C. Cut pavement along neat straight lines with either a pavement breaker or pavement saw.

D. Trench Depth: For water lines - sufficient to provide minimum cover of 42 inches over the top of the pipe; for sewer lines and storm drain lines - as shown on the plans or as specified.

E. Align trench as shown on the plans unless a change is necessary to miss an unforeseen obstruction. Should such a change be necessary, the as-built information shall be provided to the engineer and it shall be approved by the engineer.

F. For water pipe, the trench shall be cut six (6") inches below the bottom of the pipe. The pipe shall be embedded in six (6") inches of granular material all around.

G. For sewer pipe, excavate six (6") inches below the bottom of pipe and fill the bottom of the trench with crushed stone or as specified by the City Standard Water & Sewer Specifications.

H. Trenches for storm drainage pipe shall be excavated and backfilled as shown on the plans.

I. When unsuitable soil is encountered at the trench bottom, remove it to a depth required to assure support of the pipeline and backfill to the proper grade with coarse aggregate AASHTO M-43, Size No. 2 or 3.

J. Remove rock encountered in trench excavation to a depth of six (6") inches below the bottom of the pipe barrel, backfill with an approved material, and compact to uniformly support the pipe. In no cases shall solid rock exist within six (6") inches of the finished pipeline.

K. When rock borings or soundings are provided, they are for information only and do not guarantee existing conditions. Make such investigations as deemed necessary to determine existing conditions. All trench excavation shall be considered “unclassified excavation”, with no additional compensation.

3.03 SHEETING, SHORING AND BRACING

A. All trench excavation shall be in accordance with OSHA Regulations and Texas State law.

3.04 USE OF EXPLOSIVES

A. The use of explosives on this project is strictly prohibited.

3.05 DISPOSAL OF EXCAVATED MATERIAL

A. All excess excavated material that cannot be used, or is not suitable, shall be disposed of in a manner acceptable to the Architect, at no additional cost to owner.

3.06 UNAUTHORIZED EXCAVATION

A. No excavation outside or below the proposed lines and grades shown on the plans shall be provided unless approved by the Architect / Engineer.

B. Backfill areas of unauthorized excavation with the type material necessary (earth, rock or concrete) to insure the stability of the structure or construction involved.

3.07 REMOVAL OF WATER

A. Keep excavated areas free of water while work is in progress.

B. Take particular precautions to prevent the displacement of structures or pipelines as a result of accumulated water.

C. Discharge from dewatering activities shall not be made to any sanitary sewer system unless approved by the system operator.

3.08 OBSTRUCTIONS

A. Obstructions shown on the plans are for information only and do not guarantee their exact locations nor that other obstructions are not present. The contractor shall determine and verify the exact location of all obstructions and utilities prior to construction.

B. When utilities or obstructions are not shown on the plans but are present off the roadway at the location of the proposed pipeline route, the contractor may request to relocate the pipeline at no additional cost to the Owner in the roadway if necessary to avoid disturbing the utility or obstructions.

C. Exercise due care in excavating adjacent to existing obstructions and do not disturb same.

D. In the event obstructions are disturbed, repair or replace as quickly as possible to the condition existing prior to their disturbance. The repair or replacement shall be at no cost to the Owner.

E. If desired by the utility company, pay for the repair or replacement work performed by the forces of the utility company or other appropriate party.

F. If replacement or repair of disturbed obstructions is not performed after a reasonable period of time, the Owner may have the necessary work done and deduct the cost of same from payments to the contractor.

3.09 STORM SEWER BEDDING

A. Bedding for RCP/HDPE storm sewers shall be as specified in Section 501.6, 504 and 504.2.1 thru 504.2.3 of Standard Specifications for Public Works Construction, NCTCOG and site details.

3.10 GRAVITY SANITARY SEWER BEDDING

A. Always maintain proper grade and alignment during the bedding and tamping process.
   1. Any pipe dislodged during this process shall be replaced by the contractor at his expense.
   2. Dig bell holes to assure uniform support of the pipe.
   3. All bedding shall be tamped to a minimum of 95% maximum dry density.

B. Bedding for PVC Sewers:
   1. Refer to Sitework Details and City Standard Water and Sewer Specifications.
   2. Lay sewer line on six inch (6") bed of crushed stone. Place granular material to a point twelve inches (12") above top of pipe.

3.11 BEDDING FOR WATER LINES

A. The water line shall be bedded on six (6") inches of granular material in accordance with City Water and Sewer Specifications. Compact granular material to a point six inches (6") above the top of pipe.

B. Dig bell holes to assure uniform support throughout the entire length of pipe.

3.12 INITIAL BACKFILLING

A. Do not begin backfilling before checking/inspecting the grade and alignment of the pipe, the bedding of the pipe, and the joints between the pipe. If backfill material is placed over the pipe before an inspection is made, reopen the trench in order for an inspection to be made.

B. Perform backfilling by hand, together with tamping, until fill has progressed to the top of specified embedment above the pipe.
   1. Deposit appropriate material free from lumps, clods, frozen material or stones in layers approximately eight (8") inches thick.
   2. Compact by hand, or with manually operated machine tampers actuated by compressed air or other suitable means.
   3. Use tamps and machines of a suitable type which do not crush or otherwise damage the pipe.

3.13 FINAL BACKFILLING

A. After placement of the granular embedment material has been achieved, perform final backfilling depending upon the location of the work and danger from subsequent settlement.

B. Backfilling beneath existing or proposed driveways, streets, sidewalks, parking areas or any paved area:
   1. Use granular material to backfill trenches.
   2. Carefully deposit in uniform layers, not to exceed six (6") inches thick.
   3. Compact each layer according to Standard Proctor density of 95 percent by rolling ramming and tamping with tools suitable for that purpose in such a manner so as to not disturb the pipe. Moisture must be within +3 percentage points of optimum during compaction.
   4. At 200' intervals in the trench, clay check dams shall be installed to inhibit the piping of surface and/or subsurface water. The contractor shall compact full depth two foot (2') clay check dams at each location the trench enters or exits a pavement.
   5. Jetting or ponding of native material backfill will not be allowed.

3.14 FIELD QUALITY CONTROL

A. Compaction Tests: Field density testing of the completed trench backfill shall be performed by an Independent Testing Laboratory.
   1. The Laboratory shall make one density test for each 150 linear feet of trench, with a minimum of 1 tests per lift.

END OF SECTION

SECTION 31 31 00

SOIL TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Application of soil chemicals for the prevention of termite infestation.

B. Related Sections:
   1. Section 07 26 00 - Vapor Retarders

1.2 SUBMITTALS

A. Product Data: For termiticide.
   1. Include the current EPA-Registered Label for termiticide products.

1.3 QUALITY ASSURANCE

A. Applicator Qualifications: Work shall be performed by a licensed, reputable, pest control operator with an established record of at least five years successful experience in this work.

B. Regulatory Requirements: Application of soil treatment shall meet the requirements of regulatory organizations.
   1. Texas Department of Agriculture, Structural Pest Control Service, Austin, TX.
   2. Formulate and apply termiticides according to the EPA-Registered Label.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-registered label.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard from, signed by application and contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites for a period of 5 years from date of substantial completion. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

PART 2 - PRODUCTS

2.1 2.1 SOIL TREATMENT SOLUTION

A. Termiticide: Provide an EPA-registered termiticide complying with requirements of Texas Department of Agriculture, Structural Pest Control Service, Austin, TX, in an aqueous solution formulated to prevent termite infestation. Solution shall include synthetic dye to permit visual identification of treated soil. Product/manufacturer; one of the following:
   Demon MAX; Syngenta
   BaseLine™ or Dragnet SFR; FMC Corp., Agricultural Products Group

B. Dilute termiticide as recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION/PREPARATION

A. Verify the soil surfaces are unfrozen, sufficiently dry to absorb termiticide, ready to receive treatment.

B. Beginning of application means acceptance of soil conditions.

C. Notify Architect and Owner at least 12 hours prior to beginning work.

3.2 APPLICATION

A. Apply termiticide to soil at metered rates, in accordance with manufacturer's instructions or as indicated below if more stringent.

B. Applying Chemicals: Apply the solution not more than 24 hours prior to placing concrete slabs and at such time as there is reasonable assurance that no rain will fall until after the slabs have been placed.
   1. Vertical Barrier:
      a. Establish a vertical barrier in areas around the base of footings, foundation walls, grade beams, plumbing, piers, and backfill soil. Treat both sides of footings, walls, beams, and around all sides of pipes and piers.
      b. Apply at the rate of 4 gallons of emulsion per 10 linear feet per foot of depth from grade to the top of footings or the bottom of beams as each demands.
      c. Applications must be made by rodding and/or trenching in accordance with manufacturer's application instructions.
      d. Cover the treated soil with a thin layer of untreated soil or other suitable barrier such as polyethylene sheeting.
      e. Apply extra treatment to structure penetrations, pipe, ducts, expansion joints and other soil penetrations.
   2. Horizontal Barrier:
      a. Establish a horizontal barrier under concrete slabs on carton forms. Apply emulsion at the rate of 1 gallon per 10 square feet of grade.
      b. Applications shall be made by a low pressure spray.
      c. If concrete slab cannot be poured over the soil the same day it has been treated, cover treated soil immediately after application with polyethylene sheeting (Section 07 26 00 - Vapor Retarders) to prevent disturbance of the termiticide barrier.

C. Post signs in the areas of application warning workers that soil poisoning has been applied. Signs shall remain in place until areas are covered by other construction.

END OF SECTION

SECTION 31 32 00

SOIL STABILIZATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Section Includes: In-place lime treatment to stabilize the subgrade under concrete and asphaltic concrete pavement, and concrete walks, which parallel drives.

B. Related Sections:
1. Section 01 45 23 – Testing and Inspection Services.
2. Section 31 00 00 – Earthwork.
3. Section 32 13 13 – Concrete Paving

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM D 698-91 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3).

B. Geotechnical Report

C. TxDOT - Standard Specifications for Construction of Highways, Streets and Bridges, Texas Dept. of Highways and Public Transportation, as amended.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Lime Stabilization for Paving Subgrade
1. Hydrated Lime: Type A (slurry): Per TxDOT Item 260 & 264.

B. Soil: Upper 6" of the material in-place after the subgrade has been established, compacted, and shaped.

C. Lime: Hydrated lime made from "high-calcium" type limestone with an unhydrated lime content a minimum of 6% by weight at 27 lbs per SY and a "free" water content not exceeding 4% by weight. Waste lime will not be acceptable.

2.02 EQUIPMENT

A. Distributor truck or tank equipped with agitator to maintain a uniform mixture of lime and water.

PART 3 - EXECUTION

3.01 PREPARATION

A. Insure that surfaces have been brought to approximate rough grades (plus or minus 0.10 feet). Loosen and pulverize soil to a depth of 6 inches below bottom of designated paving or slab areas, including a distance of 24" outside perimeter of paving and per the paving plan/details.

3.02 PERFORMANCE - PAVING SUBGRADE

A. General: It is the primary requirement to secure a completed 6" deep subgrade of treated material containing a uniform lime mixture, free of loose areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent paving and slabs to achieve a soils Plasticity Index of not greater than 12. Construction methods and equipment shall comply to TxDOT Item 260 & 264 for Type A treatment.

B. Scarification: Excavate and scarify the material to be treated down to the secondary grade (proposed bottom of lime treatment). Wet or unstable material below the secondary grade shall be corrected by scarifying, adding lime and compacting to uniform stability. Then spread the excavated and scarified material to the desired cross-section. Full depth of treatment shall be 6 inches and full width shall be the entire area to be paved between points and lines located a minimum of 12" beyond pavement edges and 24” beyond sidewalk edge or per the plans, whichever is greater.

C. Placing Lime: Add lime to the scarified material in an amount equal to 27 lbs. per sq. yd. of 6" depth of compacted subgrade or as otherwise required to reduce plasticity index to 12 or less per ASTM D421. Apply lime mixed with water to form a slurry. Spread lime only on that area where mixing operations can be completed during the same working day.

D. Mixing: Mix the soil and lime thoroughly with suitable road mixers or other approved equipment until a homogeneous, friable mixture is obtained free from clods and lumps. Aerate or sprinkle the mixture as necessary to secure the optimum moisture content. Necessary optimum moisture content shall be at or above optimum.

E. Curing: Allow the mixture to cure for a period of from 48 to 72 hours. During the curing period keep the material moist. During this time, the section shall not be opened to vehicular traffic.

F. Final Mixing: After the required curing time, mix the material uniformly with a rotary mixer to reduce the size of the particles so that 100% will pass a 1-3/4" sieve and 60% will pass a No. 4 sieve. Lime-soil mixture pH shall be 12.4 or greater. If not possible to attain 12.4, maximum pH attainable shall be validated by laboratory test for soil being treated.

G. Compacting: Sprinkle the mixture as required and compact by rolling and tamping to a minimum of 95% standard density, ASTM D 698, and at a moisture content of optimum or better. Correct irregularities and weak spots by scarifying, adding or removing material, and re-shaping and re-compacting. Maintain the surface of the subgrade smooth, free from undulations and ruts, and to the established lines and grades.

3.03 FIELD QUALITY CONTROL

A. Compaction Tests: Field density testing of the completed stabilized subgrade under paving shall be performed by an Independent Testing Laboratory.
   1. The Laboratory shall make one density test for each 5000 sq. ft. of stabilized subgrade to insure that the specified density is obtained.

END OF SECTION

SECTION 31 35 13

RAMMED EARTH WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rammed earth walls including reinforcing, control joints, blockouts and all accessories.
   2. Associated formwork.

1.2 REFERENCES

A. ASTM C51106 Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes.

B. ASTM C61798(2003) Standard Practice for Capping Cylindrical Concrete Specimens.

C. ASTM D163300(2007) Standard Test Methods for Compressive Strengths of Molded Soil Cement Cylinders

D. CAN/CSAA300003 Cementitious Materials Compendium.

E. CSAA23.104/A23.204 Concrete Materials and Methods of Concrete Construction Methods of Test and Standard Practices for Concrete.

1.3 SUBMITTALS FOR REVIEW

A. Samples: Submit up to 12 rammed earth samples indicating color range possible.

B. Shop Drawings: Indicate expected minimum performance, reinforcing, list of materials, hydroscopic and high cement content locations, reinforcing, waterproofing details, affected related Work and expansion and contraction joint location and details. Shop drawings to be signed and sealed by an Engineer licensed to practice in Texas.

C. Submit formwork shop drawings.

D. Material Safety Data Sheets on coloring agents, cement type(s), and admixtures.

1.4 SUBMITTALS FOR INFORMATION

A. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with applicable sections of CSAA23.1/A23.2.

B. Acquire cement and soil from the same source for all work.

C. Test samples to be cured in a steam room or lime bath, as per ASTM C51106 and then capped as per ASTM C61798(2003). Create samples such that the height of the sample is twice that of the diameter. Compressive Strength to be determined at an approved geotechnical testing facility using ASTM D1633 00(2007).

D. Installer Qualifications: Company specializing in performing the work of this section must be supported by one professional with minimum 10 years rammed earth experience.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. All earth and concrete materials to be manufactured and extracted from within a 500km radius of the building site.

B. No products in this section to be on the LBC Red List.

2.2 RAMMED EARTH MATERIALS

A. Portland Cement: CAN/CSAA3001, Grey color.

B. Proprietary mix of amended soil and admixtures.

C. Water: CSAA23.1, clean and not detrimental to rammed earth.

D. Color(s) shall be as selected by Architect.

2.3 ADMIXTURES

A. Chemical Admixtures: as recommended by rammed earth installer

2.4 ACCESSORIES

A. Provide crystalline waterproofing slurry as recommended by rammed earth subcontractor.

B. Plastic lumber structural grade.

C. Acceptable Product: Bedford Technology FiberForce® plastic lumber

2.5 FORMWORK

A. No tie holes to be permitted.

B. Provide formwork surface sufficient to provide a visual 300-1200 micron finish.

C. Insulation to be extended beyond the end of the walls where window and door openings are specified.

D. Vertical and horizontal formwork joints should not be visible on finished surface.

2.6 RAMMED EARTH MIX

A. Mix and deliver rammed earth in accordance with applicable sections of CSAA23.1, and to meet the following criteria:
   1. Mix capable of producing a durable and solid rammed earth wall which does not require a sealed finish.
   2. Cement Type: Ordinary Portland Cement (OPC)
   3. Compressive Strength (100 day): minimum 10 MPa
   4. Nominal size of soil/sand: Is determined by the Fuller parabola A = 100 d/D where A is the weight of all grains with meters less then d, expressed as a proportion of the total mass which has the largest grain of diameter D. This is then modified to include angularity, parent rock, as well as fineness modulus.
   5. Slump at time and point of discharge: determined by qualified contractor

B. Puddled earth: Compressive Strength (100 day): minimum 15 MPa.

C. Provide hydrophobic admixture as recommended by rammed earth subcontractor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify all dimensions and locations required on drawings.

C. Verify requirements for rammed earth cover over reinforcement.

D. Verify that anchors, seats, plates, reinforcement and other items to be cast into rammed earth are accurately placed, positioned securely, and will not impede rammed earth placement.

E. Verify locations of all openings and embedments required for other structural, architectural and electrical work.

3.2 PREPARATION

A. Prepare previously placed concrete according to rammed earth installer's instructions. Provide crystalline waterproofing slurry at top of foundation wall.

B. Coordinate the placement of joint devices with erection of rammed earth formwork and placement of form accessories.

3.3 PLACING RAMMED EARTH

A. Place rammed earth in accordance with rammed earth contractor's recommendations.

B. Install reinforcing and interwythe connectors according to shop drawings.

C. Install individual lift for full length of wall in forms indicated on drawings approximately 100mm-200mm lifts.

D. Compress with pneumatic tampers along full length of wall.

E. Install puddled earth at the top of walls and windowsills.

F. Install embedded plastic lumber as detailed.

G. Provide hydrotropic admixture at bottom of wall and at parapet locations recommended by the rammed earth installer.

H. Notify Architect an structural consultant minimum 24 hours prior to commencement of operations.

I. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, are not disturbed during rammed earth placement.

3.4 CURING AND PROTECTION

A. Immediately after placement, protect rammed earth from rain and flowing water, premature drying, excessively hot or cold temperatures, and mechanical damage.

B. Maintain rammed earth with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of rammed earth.

3.5 FIELD QUALITY CONTROL

A. Field inspection and testing.

B. Provide free access to Work and cooperate with appointed firm.

C. Three test cylinders will be taken and tested for every 75 cu m of rammed earth placed.
   1. Minimum one test per day.

3.6 PATCHING

A. Allow Consultant to inspect rammed earth surfaces immediately upon removal of forms.

B. Patch imperfections as directed.

3.7 DEFECTIVE RAMMED EARTH

A. Defective Rammed earth: Rammed earth not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective rammed earth will be determined by the Consultant.

C. Do not patch, fill, touchup, repair, or replace exposed rammed earth except upon express direction of Consultant for each individual area.

END OF SECTION

SECTION 31 63 29

DRILLED CONCRETE PIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Drilling and cleaning pier holes
2. De-watering of shafts and removal of spoil
3. Casing pier holes

B. Products Installed, Not Furnished Under This Section
1. Concrete and reinforcing steel
2. Anchor bolts, templates and dowels

1.2 REFERENCES (Latest Edition)

A. Codes and Specifications
1. Standards and specifications provided by the Association of Drilled Shaft Contractors
2. American Concrete Institute (ACI):
a. ACI 336.1, Specification for the Construction of Drilled Piers
b. ACI 336.3, Report on Design and Construction of Drilled Piers

1.3 BASIS FOR BIDS

A. Definitions
1. Ground surface: Final grade based on finish floor elevations in Contract Documents.
2. Pier depth: Total depth of pier calculated as the sum of:
a. Depth from ground surface to top of bearing stratum
b. Depth that casing extends into bearing stratum
c. Required penetration into bearing stratum
3. Bid depth: Pier depth based on top of bearing stratum elevation in Contract Documents.
4. Pay depth: Actual depth of pier as installed.

B. Contract Sum
1. Calculate Contract Sum based on bid depth.
2. Do not include temporary casing in Contract Sum.

C. Unit Prices
1. Piers: provide add and deduct unit price per linear foot shorter or longer than bid depth
a. Above bearing stratum
b. Within bearing stratum.
c. No additional depth of penetration into bearing stratum will be included in the pay depth unless required in writing by the inspecting agency.
2. Casings: provide add and deduct unit price per linear foot for steel casing installation and removal. Base unit price on actual length of temporary steel casing measured from ground surface to bottom of casing.
3. Provide unit prices for complete Work including labor, materials, overhead, taxes and profit.
4. Reconciliation: Per pier diameter category for net add or net deduct, not per individual pier. See structural drawings for pier diameter categories. Example: For a pier category consisting of a total of two piers, 1’-0” of additional drilling on one pier and 1’-0” less drilling on a second pier would result in a net of Zero feet of drilling for that pier diameter category.

1.4 QUALITY ASSURANCE

A. Qualifications
1. Contractor: at least 3 years of experience in similar applications
a. Relevant experience to anticipated subsurface materials, water conditions, shaft sizes and special techniques required

2. Demonstrate to Architect dependability of equipment and techniques to be used, when requested.

B. Field Samples
1. Prior to pier installation, drill 1 sample pier to test proposed installation techniques. Do not place concrete until pier hole is observed by Architect.
a. Do not incorporate sample pier(s) into Work. Drill sample piers in location that will not interfere with foundation piers.
b. Provide additional samples until satisfactory and successful technique is established, at no additional cost to Owner.

C. Conform to requirements of ACI 336.1, except as modified by requirements of this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store reinforcing cages off ground and protect from contamination by dirt, grease and corrosion.

B. Deliver concrete to site in timely manner and in sufficient quantities to allow concreting of each pier as monolithic unit.

C. Coordinate delivery of concrete to allow placement to begin within 6 hours of completion of drilling.

PART 2 - PRODUCTS

2.1 MATERIALS - Refer to related sections for materials installed, not furnished under this section.

2.2 FABRICATION

A. Prior to drilling pier holes, fabricate reinforcing cages in stock lengths suitable for cutting to required lengths. Bend reinforcing as detailed.
1. Do not splice vertical reinforcing at vertical brace piers.
2. Except as otherwise required, vertical reinforcing may be spliced beyond top 15 ft of pier with a Class B tension splice. Lap and tie bars at splices.
3. Where required, provide mechanical bar splices.
4. Do not use cross wire ties that would interfere with tremie pipe or concrete free falling down the center of the cage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to beginning installation, review subsoil investigation report for site provided by Owner and become thoroughly familiar with anticipated subsoil conditions.

B. Examine site for obstructions to drilling, such as power lines, utilities, material stockpiles, boulders and uneven surfaces. Report anticipated problems to Architect in timely manner so as not to delay schedule of Work.

C. Locate existing underground utilities and notify Architect of conflicts with Work.

3.2 PREPARATION

A. Have ready at site equipment anticipated to be necessary for successful installation of piers, including power augers, core barrels, tremies, hoppers, chutes, and casing, as applicable.

B. Maintain in ready condition dowels, templates, and anchor bolts required for pier installation.

3.3 INSTALLATION

A. Drilling Straight Shaft Pier Holes
1. Drill pier holes with power augers or core barrels suitable for subsoil conditions at site.

2. Drill pier holes of required diameters to bearing stratum and penetrate bearing stratum to required depths below top of stratum.
3. Where casing is required, increase pier hole diameter as necessary to accommodate casing having inside diameter not less than required shaft diameter to depth necessary to seal shaft.
4. Where casing is required, measure required depth of penetration into bearing stratum from top of stratum or from bottom of casing, whichever is deeper from ground surface.

B. De-watering Pier Holes
1. Remove standing water from pier holes to within 3 inches of hole base by bailing or pumping.
2. Where flowing water is encountered, or required water level cannot be maintained, use casing.

C. Casing Pier Holes
1. Where flowing water or caving soil is encountered use temporary steel casings to seal sides of shaft.
2. Provide watertight, steel casings of adequate strength to withstand handling stresses and concrete and earth pressures.
3. Extend casings only to depth required to seal off water or caving soil.
4. Extract casings in vertical lifts, maintaining adequate head of concrete to prevent caving of soils. Do not rotate casing during removal.

D. Placing Reinforcing Cages, Dowels and Anchor Bolts
1. Place reinforcing steel cages accurately in shafts and hold in position during placement of concrete.
2. Place dowels and anchor bolts in position and maintain proper location and elevation with templates.
3. Use spacer rollers to maintain position of cage within shaft and to maintain minimum 3 inches of concrete cover without casing, and 4 inches of concrete cover with casing.
4. Use end blocks to support cage at required elevation maintaining proper clearance at base of pier.

E. Placing and Consolidating Concrete
1. Clean pier shafts of accumulated loose material before placing concrete and remove water to within 3 inches of base of shaft.
2. Place concrete within 6 hours of drilling.
3. Place concrete using collection hopper with steel outlet pipe to direct concrete down the center of the shaft. Placing concrete directly into the shaft from concrete truck chute is not allowed.
4. Extend tremie pipe as required to limit concrete free fall height as follows:
   a. Shaft diameter 18 inches or less: 10 feet max free fall
   b. Shaft diameter 20 to 30 inches: 30 feet max free fall
   c. Shaft diameter 32 inches or larger: 60 feet max free fall
5. Place concrete in one continuous operation for each pier.
6. Consolidate top 6 feet of each pier with concrete vibrator.
7. Where water rises to top of pier during placement, remove over-wetted concrete and replace with sound, dense material.
8. Remove and replace portions of concrete that become contaminated with mud or spoil material during placement.
9. Where tops of pier holes become mushroomed during drilling or installation procedures, use round forms to maintain constant diameter.

F. Tolerances
1. Maximum lateral variation off centerlines: 3 inches
2. Plumbness of vertical piers within 1 ½ percent of shaft depth to bearing stratum.
3. Shaft diameter: plus 2 inches, minus 0
4. Top of pier elevation: plus one inch, minus 3 inches
5. Penetration into bearing stratum: minus 0, plus 1 foot.
6. Levelness of pier bottom bearing surface: within 1 vertical to 12 horizontal of level
7. Placement of dowels at tops of piers: plus or minus 1 inch horizontal and vertical. Set dowels in open shaft prior to concrete placement, unless wet setting of dowels is approved by Architect.
8. Placement of anchor bolts: plus or minus ¼ inch horizontal, plus or minus ½ inch vertical.

3.4 FIELD QUALITY CONTROL

A. Testing Laboratory and Inspection Services
1. Inspect drilling of each pier hole
   a. Determine location of required bearing stratum
   b. Measure depth to bearing stratum from ground surface

c. Measure overlap of casing into the bearing stratum where casing required.
d. Measure depth of penetration into stratum
e. Measure shaft diameters.
f. Measure casing diameter where casing required
g. Inspect condition of base prior to placing concrete

2. Inspect reinforcing cages
   a. Check bar sizes and quantity
   b. Check tieing and splicing of cages
   c. Monitor placement and securement techniques
3. Monitor concrete placement
   a. Monitor time interval between drilling and placement.
   b. Inspect placement techniques and conditions.
   c. Inspect concrete quality at tops of shafts.
4. Material Tests: refer to sections for products installed, not furnished under this section.
5. Field Conditions: where un-anticipated subsurface conditions prevent proper installation of piers, do not proceed with Work until directed by Architect.
6. Pier Log: for each pier record the following and submit to Architect for review:
   a. Identification mark
   b. Plan view identifying pier location
   c. Shaft diameter
   d. Top of bearing stratum elevation
   e. Bottom of pier elevation
   f. Penetration of bearing stratum
   g. Pier reinforcing (vertical bars and ties)
   h. Steel cage length
   i. Depth and diameter of casing, where casing required
   j. Top of Pier Elevation
   k. Concrete quantity
   l. Date and time drilling completed
   m. Date and time concrete placement begun and completed
   n. Plumbness variation
   o. Condition of drilled hole before placement of concrete
   p. Notes regarding piers not in compliance with Contract Documents

B. Adjusting
   1. Re-drill piers for which time lapse between drilling and concreting exceeds maximum as determined by Architect at no additional cost to Owner.
   2. Replace piers installed without required inspection as directed by Architect at no additional cost to Owner.
   3. Test and/or correct pier installations suspect of deficient quality as directed by Architect at no additional cost to Owner.
   4. Pier shafts larger than required diameter, except where casing is required, may require additional vertical reinforcing, as instructed by Architect at no additional cost to Owner.
   5. Remove mushrooms - before concrete cures, remove excess concrete from tops of piers to maintain pier shafts of constant diameter.

C. Clean-up
   1. Remove spoil and debris from the site and legally dispose.

END OF SECTION

SAMPLE WORKSHEET "I"
PIER DEPTH RECONCILIATION WORKSHEET

PROJECT _____ PAGE _____ OF _____

PIER DIAMETER THIS PAGE _____

		A MINUS B = C x D = E				
	PIER NO.	ESTIMATED BEARING ELEVATION	ACTUAL BEARING ELEVATION	AMOUNT DEEPER (+) OR SHALLOWER (-) THAN ESTIMATED BEARING	APPLICABLE UNIT PRICE FROM BID FORM (NOTE: EXTRA(+) OR CREDIT (-))	NET EXTRA COST OR CREDIT DUE PER PIER
1						
2						
3						
4						
5						
6						
7						
8						
9						
						TOTAL OF COLUMN "E"

SAMPLE WORKSHEET "II"

PIER CASING LENGTH RECONCILIATION WORKSHEET

PROJECT _____ PAGE _____ OF _____

PIER DIAMETER THIS PAGE _____

		F MINUS A = G			F MINUS B = H		
	PIER NO.	GROUND ELEVATION AT PIER	ESTIMATED BEARING ELEVATION	ESTIMATED CASING LENGTH	GROUND ELEVATION AT PIER	* ACTUAL BEARING ELEVATION	ACTUAL CASING LENGTH
1							
2							
3							
				SUM OF FIGURES IN COLUMN "G" x SPECIFIED BID BASIS PERCENTAGE FOR PIERS TO BE CASED = TOTAL ESTIMATED CASING LENGTH			SUM OF FIGURES IN COLUMN "H" = TOTAL ACTUAL CASING LENGTH

TOTAL ACTUAL CASING LENGTH - TOTAL ESTIMATED CASING LENGTH x APPLICABLE UNIT PRICE EXTRA(+) OR CREDIT(-) = TOTAL COST OF CASINGS

TOTAL COLUMN "E" ON WORKSHEET "I" + TOTAL COST OF CASINGS ON WORKSHEET "II" = TOTAL DOLLAR CHANGE TO CONTRACT

*

IF THE ELEVATION OF THE BOTTOM OF CASING DIFFERS FROM THE ACTUAL BEARING ELEVATION, USE BOTTOM OF CASING ELEVATION WHEN CALCULATING TOTAL ACTUAL CASINGS.

SAMPLE "III"
GLOSSARY OF TERMS USED IN SAMPLE WORKSHEETS "I" AND "II"

COLUMN "A" - ESTIMATED BEARING ELEVATION:

For bidding purposes, it is the estimated elevation shown on the typical pier detail in the structural drawings at which point pier penetration commences.

COLUMN "B" - ACTUAL BEARING ELEVATION:

Actual elevation at which the bearing material is encountered by each pier as determined in the field by the independent testing laboratory.

COLUMN "C" - AMOUNT DEEPER (+) OR SHALLOWER (-) THAN ESTIMATED BEARING ELEVATION:

The amount, in feet, the bearing material was encountered above or below the estimated bearing elevation.

COLUMN "D" - APPLICABLE UNIT PRICE FROM BID FORM, EXTRA (+) OR CREDIT (-):

The applicable Extra and/or Credit unit prices per linear foot including drilling, reinforcing and concrete shown on the successful contractor's Bid Form.

COLUMN "E" - NET EXTRA COST OR CREDIT DUE PER PIER:

Net extra cost or credit due per individual pier (exclusive of casing, if required).

COLUMN "F" - GROUND ELEVATION AT PIER:

The elevation of ground at pier at time pier is drilled.

COLUMN "G" - ESTIMATED CASING LENGTH:

The estimated total linear feet of casing required for bidding purposes.

COLUMN "H" - ACTUAL CASING LENGTH:

The actual total linear feet of casing utilized during drilling.

SECTION 32 05 19

GEOTEXTILES FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: All labor, materials, services, equipment and appliances required in conjunction with or properly incidental to furnishing and installation of drainage mat and filter fabric complete, including:
   1. Drainage mat for walls below grade.
   2. Non-woven filter fabric at earth fill around granular drainage course.
   3. All other locations where "Drainage Mat" or "Filter Fabric" are indicated.

B. Related Sections:
   1. Section 03 11 13 - Structural Concrete Forming.
   2. Section 03 31 00 - Structural Concrete.
   3. Section 07 13 26 - Self-adhering Sheet Waterproofing.
   4. Division 22 - Sub-soil drainage system.
   5. Section 31 23 03 - Excavation and Fill for Building Pad.

1.2 SUBMITTALS

A. Conform to SECTION 01 33 23 - SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Design Data: Submit complete, exact and specific design data for drainage mat and filter fabric products specified.

C. Product Data: Submit manufacturer's specifications to evidence compliance with these specifications. Submit manufacturer's installation instructions.

D. Samples: Submit two 12" square samples of each product specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Filter Fabric
   1. Manufacturers: Provide one of the following:
      a. "Mirafi 140 N": Mirafi, Div. of Ten Cate Nicolon Corp., 365 South holland Drive, Pendergrass, GA 30567 (phone 214.783.3475)
      b. "Propex 451": Amoco Fabrics and Fibers Co., 260 The Bluffs, Austell, GA 30168, (phone 214.701.9833)
   2. Product/Material Performance Requirements
      a. Retention Ability (Piping Resistance)
         1) Filter fabric fiber/pore structure shall be capable of retaining a broad range of soil gradations.
         2) Particles larger than the fabric's pore size shall be retained.
         3) Filter fabric structure shall promote bridging of fine soil particles over the pores in the fabric to enable the filter fabric to retain silt and clay-sized particles that are smaller than the fabric pores.
      b. Permeability: At least ten times that of the protected soil.
      c. Clogging Resistance: Maximum allowable gradient ratio is 3.
   3. Property Values (Property/Unit/Test Method)
      a. Weight: 4.5 oz./sy: ASTM D 3776
      b. Grab Strength: 120 lbs: ASTM D 4632
      c. Grab Elongation: 50%: ASTM D 4632
      d. Trapezoid Tear Strength: 50 lbs: ASTM D 4533
      e. Mullen Burst Strength: 240 psi: ASTM D 3786
      f. Puncture Strength: 70 lbs: ASTM D 4833
      g. Permittivity: 1.5/sec ASTM D 4491
      h. Water Flow Rate: 120 gpm/sf: ASTM D 4491
      i. Apparent Opening Size (AOS): 70 U.S. Std. Sieve: ASTM D 4751

B. Drainage Mat
   1. Manufacturers: Provide one of the following:
      a. "Hydroduct": W.R. Grace, 1420 Century Drive, Suite 400, Carrollton, Texas 75006, (972.242.3992)
      b. "G100N": Mirafi, Div. of Ten Cate Nicolon Corp., 365 South Holland Drive, Pendergrass, GA, 30567 (phone 214.783.3475)
   2. Product/Material Description: Drainage mat shall be a composite structure consisting of:
      a. A three-dimensional, high impact-resistant, polymeric sheet.
      b. Filter fabric, securely bonded to the dimpled surface of the molded polymeric sheet to maintain a rigid surface, thus preventing intrusion of the fabric into the flow channels when backfilled. The fabric shall extend beyond the edges of the polymeric sheet (3" minimum) to provide overlap with adjacent panels and discharge pipe.
      c. Attachment Material(s): Mastic, furring strip, impaling pins, or square cap nails, as recommended by the manufacturer, and as approved, in writing, by the waterproofing manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION OF FILTER FABRIC

A. Install in exact accordance with filter fabric manufacturer's latest published requirements, instructions, specifications, and details.

B. Techniques
   1. Unroll fabric over bottom of excavation.
   2. Include sufficient width for a minimum 6" overlap.
   3. Include sufficient length to extend beyond building lines to wrap around subsoil drain piping envelope as shown.
   4. Tape seams as recommended by manufacturer.
   5. Ensure fabric continuity during granular fill placement and compaction.
   6. Fabric shall be wrapped around subsoil drain piping and granular drainage envelope and attached to drainage mat as indicated.

3.2 INSTALLATION OF DRAINAGE MAT

A. Prepare substrate surfaces to insure proper and adequate installation, in exact accordance with the contract documents and manufacturer's requirements.

B. Field measure and verify dimensions as required.

C. Protection of Adjacent Areas or Surfaces:
   1. Protect adjacent areas or surfaces from damage as a result of the work of this section.
   2. Avoid damage to waterproofing.

D. Install in exact accordance with manufacturer's latest published requirements, instructions, specifications and details.

E. Wall Installation
   1. Beginning at bottom of wall, attach the first panel to the waterproofed wall with mastic, furring strip, impaling pins or square cap nails, as approved in writing by the waterproofing membrane manufacturer.
   2. Attach the panel with the filter fabric side out, away from the wall surface.
   3. Peel or trim fabric from top of the attached panel to expose 3" of core.
   4. Overlap core of second panel 2" and interlock.
   5. Cover the joint with the fabric flap.
   6. Repeat to cover the wall surface.
   7. Shingle each course, overlapping the panels in the direction of water flow.

F. Place bottom of drain panel behind subsoil drainpipe. Peel back the bottom of fabric flap. Wrap the filter fabric from front to back completely around the pipe and tuck behind core.
   1. Cover all terminal edges with the fabric flap by tucking it behind the core. For corners and other uneven surfaces, attach the fabric flap to the wall with mastic to prevent soil intrusion behind the panels.
   2. Backfill within seven days, or as specified by the Architect. Place and compact the fill material 6" above the top edge of the drainage mat.

G. Backfilling: (Refer to SECTION 31 23 03 - EXCAVATION AND FILL FOR BUILDING PAD)
   1. Place and compact soil directly adjacent to drainage mat using plate laboratory compactors.
   2. Turn plate compactor exhaust away from the drainage mat.

3.3 ADJUSTMENT AND CLEANING

A. Repair or replace any damaged or otherwise defective materials.

B. Clean up all debris caused by the work of this section, keeping the premises clean and neat at all times.

END OF SECTION

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SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Section Includes: New concrete walks, curbs and gutters, paving, approaches, and other concrete flatwork outside the building.

B. Related Sections:
1. Section 31 00 00 - Earthwork

1.03 REFERENCES

A. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.

B. ACI 305 - Recommended Practices for Hot Weather Concreting.

C. ACI 306 Recommended Practices for Cold Weather Concreting.

D. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

E. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

F. ASTM C309, Type II – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

G. NCTCOG - Standard Specifications for Public Works Construction.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301.

B. Obtain materials from same source throughout.

C. City Standards: Street sidewalks, curbs and gutters, and approaches shall be constructed to meet or exceed the requirements of the City standard specifications (or NCTCOG) where the City standards are applicable.

1.05 SUBMITTALS

A. Product Data: Submit concrete mix designs in accordance with SECTION 01 33 23 - SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Include data on joint filler, admixtures and curing compounds.

C. Submit manufacturer's instructions under provisions of SECTION 01 33 23 - SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

D. Confirm proposed joint layout shown on plans; submit revised layout for approval prior to starting work.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not place pavement when base surface or ambient temperature is less than 40 degrees F, or if base surface is wet or frozen.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cements: ASTM C 150, Type I, domestic manufacture.

B. Fly Ash: ASTM C 618, Class F or C.

C. Fine Aggregate: ASTM C 33, washed sand with a fineness modulus of between 2.50-3.00.

D. Coarse Aggregate: ASTM C 33, clean crushed stone or washed gravel. The nominal maximum particle size shall not exceed 1/5 of the narrowest dimension between forms or ¾ of the minimum clear spacing between reinforcing bars.

E. Admixture: ASTM C 494, Types "A", "D" and "E", water reducing, chloride-free admixture. Product manufacturer; one of the following:
PSI; Gifford-Hill & Co., Inc.
Pozzolith; Master Builders
Plastocrete; Sika Chemical

F. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures, equal to Master Builders "Micro Air".

G. Water: ASTM C 94, Clean and potable.

H. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

I. Formwork:
1. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
2. Use flexible or curved forms for curves of a radius 100 feet or less.
3. Use forms of size and strength to resist movement during concrete placement.
4. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

J. Reinforcement:
1. Reinforcement Bars: ASTM A 615, Grade 60, deformed.
2. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs. Provide with closed sleeves at one end to allow one inch movement.
3. Tie Bars: ASTM A 615, Grade 60, deformed.
4. Bar Supports: chairs for spacing, supporting, and fastening reinforcement bars, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from plastic to support bars at the proper depth per the details.

K. Concrete shall meet the requirements specified in plans and specification. Paving and 5”” flatwork shall be 6 sack of cement content per cubic yard with a minimum compressive strength of 4000 psi at 28 days and 3000 psi at 28 days for 4” flatwork. (Entrained Air: 3-

6%, Slump: 3-5 inches, Fly Ash Replacement – 20% max).

L. Expansion Joint Filler:
1. ASTM D 1751 preformed strips of asphalt saturated cane fiberboard for joints in standard finished flatwork (walks, curbs and gutters).
2. ASTM D 1752, Type I preformed strips of elastic sponge rubber compound for joints to be caulked with sealant and joints in architectural concrete flatwork.
3. The use of redwood expansion joints is prohibited.

M. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
Product manufacturer; one of the following:
Crafco Inc.; RoadSaver Silicone SL.
Dow Corning Corporation; 890-SL.

N. Joint Sealant Backer Rod:
1. Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
2. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.02 MIXING AND DELIVERY

A. Measurement of concrete materials, mixing, and delivery of fresh concrete to the project shall meet the requirements of ASTM C 94. Transit-mixed concrete supplier shall have a plant with sufficient capacity and transportation facilities to assure continuous delivery at the rate required.

B. Mix concrete in accordance with ASTM C94, Alternative No. 2, or ACI 304.

C. Deliver concrete in accordance with ASTM C94.

D. Select proportions for normal weight concrete in accordance with ACI 301 Method 1. Mix not less than one minute after materials are in mixer.

E. Do not transport or use concrete after 90 minutes has expired from time of initial mixing.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify compacted subgrade is ready to support paving and imposed loads, free of frost, smooth and properly compacted.
B. Verify gradients and elevations of base are correct, and proper drainage has been provided so that water does not stand in the area to receive paving.

C. Beginning of installation means acceptance of existing conditions

3.02 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Notify Architect, Owner, and testing laboratory, minimum 24 hours prior to commencement of concreting operations.

C. Grade Control: Establish and maintain the lines and grades for concrete site work items by means of line and grade stakes. Complete any fine grading required to prepare the subgrade. Maintain the finished subgrade cushions in a satisfactory condition.

3.03 INSERTS AND ACCESSORIES

A. Make provisions for installation of inserts, accessories, anchors, and sleeves.

3.04 INSTALLATION

A. Forming: Set forms to lines and grades, and brace and secure to withstand wet concrete without deflection or leakage. Stake forms securely in position with joints keyed to prevent relative displacement. Clean and oil forms each time they are used. Refer to Section 03 11 00 for additional installation requirements.
   1. Walks: 4" – 5” thick. Surfaces shall be crowned or sloped to drain.
   2. Curbs and Gutters: As detailed.
   3. Paving, Drive Approaches: Thicken edges as required.
      a. 5" thick – Light-Duty Parking Areas Traffic (Parking Areas)
      b. 6" thick – Medium-Duty Parking Areas (Drives)
      c. 7” thick –Fire Lanes, Service and Dumpster Areas

B. Reinforcing: Install reinforcing to meet the requirements of SECTION 03 2000 - CONCRETE REINFORCEMENT. Where reinforcement is not specifically detailed, reinforce pavement and flatwork with #3 rebars at 18" o.c. each way.

C. Concrete: Place concrete to meet the requirements of SECTION 03 3000 - CAST-IN-PLACE CONCRETE.
   1. Place concrete in accordance with ACI 301 and 304. Deposit concrete so that specified slab thickness will be obtained with use of a vibratory screed and finishing operations. Minimize handling to prevent segregation. Consolidate concrete by suitable means to prevent formation of voids or honeycombs. Exercise care to prevent disturbance of forms and reinforcing and damage to vapor retarder. Place concrete to lines and levels shown, properly sloped to drain into adjacent yard areas or drainage structures. **Concrete shall be placed using a walk behind screed machine (Magic Screed). In addition, a backpack vibrator shall be used. A minimum of two (2) screed machines and two (2) backpack vibrators shall be present during all concrete pours.** The surface shall be troweled and edged with a steel trowel and then broomed to obtain a smooth, uniform brush finish.
   2. Hot Weather Placement: ACI 305.
   3. Cold Weather Placement: ACI 306.
   4. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
   5. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
   6. **The Contractor shall not back over the steel at any time while pouring concrete. Construction sequencing efforts shall be utilized in order to successfully make each concrete pour. If necessary, the Contractor shall utilize concrete pumping to perform the work.**

D. Expansion Joints: Locate expansion joints around fixed objects within or abutting concrete, and at intervals of not more than 35 ft. o.c. along walks and curbs and 150 ft. o.c. along drive and parking paving unless otherwise shown on the plans.
   1. Install preformed filler with the top edge approximately 1/4" below the finished concrete surface to leave a neat, straight joint.
   2. Joints shall be ½" wide unless specifically dimensioned otherwise on the drawings. Joint edges shall be rounded with an edging tool.
   3. There shall be no connection by reinforcement or keyway across expansion joints. Joints shall be held in alignment with sleeved, smooth dowels where required.
   4. The use of redwood expansion joints is prohibited.

E. Scoring:
1. Saw cut walks, approaches, and paving using an abrasive or diamond blade. Cut joint width shall be 1/8" and depth shall be 1/4" deep at walks and 1/3 slab thickness at approaches and paving. Cutting of joints must be done as soon as concrete surface is firm enough not to be torn or damaged by the blade (within 4 to 12 hours), and before random shrinkage cracks can form in the concrete slab.

    a. Score walks at approximately 5-foot intervals each way. Where walks abut curbs, the scoring of walks and curbs shall align.
    b. Score curbs and gutters at approximately 5-foot intervals. Score curbs to match paving sawcuts.
    c. Score approaches and paving at approximately 12-foot intervals each way or as shown.

F. Standard Finishing: Strike slabs off true by double screeding to the required level at or below the elevations and grades shown on the drawings. Set edge forms and screed strips accurately to produce the designated elevations and contours.
1. Walks: Float with wood floats to true planes with no coarse aggregate visible. Hand trowel to produce smooth surfaces. Brush surfaces with a soft fiber brush to produce a uniformly striated finish. Edge concrete surfaces with a rounded edging tool.
2. Curbs and gutters: All curbs shall be formed and finished with a preformed mechanical mule. No hand formed curbs shall be allowed except in those areas that require transitioning to a laydown curb, inlet or radii less than 4 feet. Cross brush surfaces with a soft fiber brush to produce a fine brush finish.
3. Approaches: Screed and float to a monolithic medium float finish and belt with a canvas belt to produce a herringbone texture finish.
    a. Curb Ramps: Provide tooled grooves with chemical staining of concrete as detailed.

G. Curing:
1. Cure concrete 7 days. Coat exposed surfaces with **white pigmented curing compound** for pavement areas and **clear curing compound** for sidewalk/flatwork areas. Protect surfaces from pedestrian and vehicular traffic during the curing period. Damaged areas shall be re-sprayed. Curing compound shall conform to the specifications of ASTM C309, Type 2.

2. Removing Forms: Forms shall remain in place for at least 12 hours after concrete has been placed and finished. Remove forms without damaging the concrete. Bars and heavy tools shall not be used to pry against the concrete in removing the forms. Backfill all curbs.

3.05 FIELD QUALITY CONTROL

A. Concrete Tests: Testing and acceptance of concrete shall meet the requirements specified in the plans and specifications and by the geotechnical firm.

B. Grade and Smoothness Tests:
1. Plan Grade: Finished surface of the flatwork shall not vary more than 0.04 ft. above or below the plan grade or elevation. Finished surfaces of abutting pavement and walks shall coincide at their juncture. Where a new pavement or walk abuts an existing surface, transition pavement or walk strip shall be installed.
2. Surface Smoothness: Finished surface of the flatwork shall have no abrupt changes of more than 1/8" and shall not deviate from the testing edge of a 12 ft. straight edge more than 1/4" plus or minus tolerance. Flow line of gutters shall not deviate from the testing edge of a 10 ft. straight edge more than 1/8" plus or minus tolerance.

C. **Concrete Cracking:**
Contractor is responsible for controlling all concrete cracking. If more than one (1) crack per panel occurs, the Contractor may be required to remove and replace the panel as directed by the Engineer or Owner.

3.06 CLEANING

A. Remove debris, scraps, surplus materials, tools and equipment from the premises upon completion of the work. Clean concrete droppings from walks and curbs. Leave the graded areas free of debris and rubble.

3.07 PROTECTION

A. Immediately after placement, protect concrete under provisions of SECTION 01 50 00 – CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. The pavement shall be closed to all traffic, including vehicles of the Contractor, until the concrete is at least 7 days old or has attained a minimum average of 3,000 psi compressive strength. Repair any damage to the pavement prior to the acceptance by Owner at no additional cost to the Owner. This does not relieve the Contractor from the normal liabilities, and maintenance responsibilities, implied or otherwise, for the pavement or other items.

END OF SECTION

SECTION 32 15 40

DECOMPOSED GRANITE

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

A. Requirements of “General Conditions of the Contract” and of Division I, “General Requirements”, apply to work in this Section with same force and effect as though repeated in full herein.

1.02 SCOPE OF WORK

A. Furnish materials, labor, transportation, services, and equipment necessary to install decomposed granite paving as indicated on Drawings and as specified herein.

B. Work related in other Sections:
1. 32 93 00 TREES, SHRUBS, AND GROUNDCOVERS
2. 32 84 00 PLANTING IRRIGATION

1.03 REFERENCES

A. ASTM C 136 – Method for Sieve Analysis for Fine and Coarse.

1.04 SYSTEM DESCRIPTION

A. Decomposed granite paving

1.05 SUBMITTALS

A. In accordance with Division 1.

B. Submit specification data Cut Sheets for products specified under this Section.

C. Products: Five-pound sample and sieve analysis for grading of decomposed granite material.

1.06 TESTS

A. Perform gradation of decomposed granite material in accordance with ASTM C 136.

1.07 MOCK-UPS

A. Install a 4-foot wide x 10-foot long mock-up of decomposed granite paving with compacted with a vibrating plate at location as directed by Owner’s Authorized Representative.

B. This mock-up will be the standard from which future work will be judged.

C. Remove Mock-up completely prior to Final Payment.

1.08 ENVIRONMENTAL CONDITIONS

A. Do not install decomposed granite paving during rainy conditions.

1.09 COORDINATION

A. Notify contractors related to installation of his work in ample time, so as to allow sufficient time for those contractors to perform their portion of work.

1.10 QUALITY ASSURANCE

A. Installer: Provide evidence to indicate successful experience in providing decomposed granite.
1. Experience: Minimum 5 years.

1.11 INSPECTION OF SITE

A. Verify conditions at site that affect Work of this Section, and take field measurements as required. Report major discrepancies between Drawings and field dimensions to Owner's Authorized Representative prior to commencing Work.

1.12 EXCESS MATERIALS

A. Provide Owner's Authorized Representative with the following excess materials for use in future decomposed granite paving repair:
1. Four, 40 lb. Bags of decomposed granite screenings with source location provided.

PART 2 - PRODUCTS

2.01 DECOMPOSED GRANITE SCREENINGS

A. 1/4" minus size, washed, natural, tan-colored crushed granite stone, free of clay, friable materials and debris and graded in accordance with ASTM C 136 within the following limits:

1. Gradation: As determined by ASTM C 136 methodology.

Sieve Size	Percent Passing
1/4"	100
No. 4	80 - 100
No. 30	25 to 55
No. 100	10 to 20
No. 200	7-15

2. Sand Equivalent: As determined by ASTM D-2419 methodology. Shall have a minimum of 30.
3. R-Value: As determined by ASTM D-2488 methodology. Shall have a minimum of 70.

2.02 FABRIC UNDERLAY

A. US Fabrics, US 205NW, 100% polypropylene staple filaments. Weight: 8oz per SY, Tensile strength 205 lbs., or approved equal.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Verify that gradients and elevations of subgrade are correct. Ensure that a minimum of 2% of cross slope will be provided. Contact Owner's Authorized Representative if this minimum percentage will not be maintained.

B. Verify that fabric underlay will extend to edge of decomposed granite paving. Wrap up edges of fabric 2" on all sides.

C. Remove loose material from compacted subbase surface immediately before placing decomposed granite screenings.

D. Wet and compact sub-grade prior to placing decomposed granite screenings.

3.02 PLACEMENT OF DECOMPOSED GRANITE SCREENINGS

A. Place decomposed granite screenings in two inch lifts to a depth of four inches, applying moisture and compacting with a vibratory plate after each lift.

B. Grade and smooth decomposed granite paving per approved Owner's Authorized Representative mock-up.

C. Apply water until moisture penetrates to full depth of decomposed granite screenings. It is critical that full section of decomposed granite screenings receive water at this time.

D. Upon thorough moisture penetration, compact decomposed granite screenings to within 90% relative compaction by using a vibrating plate.

E. Take care in compacting decomposed granite screenings when adjacent planting and irrigation systems.

F. Allow the finished surface enough time to dry completely before allowing traffic.

3.03 REPAIRS AND PROTECTION

A. Remove and replace decomposed granite paving that is damaged, defective, or does not met requirements of this Section.

B. Protect decomposed granite paving from damage until Final Payment.

3.04 CLEANUP

A. Upon completion of Work under this Section, remove rubbish, waste and debris resulting from Contractor's operations. Leave work area in a neat and clean condition.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A . Section Includes: Pavement marking on Portland Cement Concrete Pavement.

B. Related Sections:
1. Section 32 13 13 - Concrete Paving

1.03 REFERENCES

A. Federal Specification (FS):
1. FS - TT-P-115E Paint, Traffic, Highway, White and Yellow.

1.04 PROJECT CONDITIONS

A. Environmental Requirements Apply paint when ambient temperature is 50°F. or above, and relative humidity is below 85%.

1.05 QUALITY ASSURANCE

A. Installer: Shall have a minimum of 2 years' experience in the layout and striping of parking lots.

B. Job Conditions: Do not apply marking paint when weather is foggy or rainy, or ambient or pavement temperatures are below 40 degrees F., nor when such conditions are anticipated during eight hours after application.

1.06 SUBMITTALS

A. Submit manufacturer's product data and installation instructions.

B. Substitutions: Submit in accordance with SECTION 01 62 00 - PRODUCT OPTIONS.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Traffic Paint: Fed. Spec. TT-P-115E, Type III alkyd-chlorinated rubber-chlorinated paraffin marking paint. Striping colors per plans and City requirements. Provide Premium Chlorinated Rubber Base Paint as manufactured by Highway Signs & Paint, Inc. (phone 214 446-1605), or approved equivalent.

B. Cleaning Solvent: VM & P Naphtha.

2.02 EQUIPMENT

A. Applicators: Hand-operated push type marking machine or conventional airless spray equipment with guide lines and templates.

PART 3 - EXECUTION

3.01 PREPARATION

A. Surface Conditions: Clean and dry free from dirt, loose paint, oil, grease, wax, and other contaminants.
   1. Asphalt Surfaces: Allow asphaltic concrete to cure a minimum of 48 hours prior to application of marking paint.

B. Equipment Condition: Clean previously used paint and solvent from application equipment, using VM & P Naphtha.

C. Paint: Stir contents thoroughly from bottom of container. Do not thin paint.

D. Locate markings as indicated on Drawings. Provide qualified technician to supervise equipment and application of markings. Lay out markings using guide lines, templates and forms.

E. Allow paving to cure before painting as required by manufacturer of traffic paint.

F. Allow protective coating to cure a minimum of 48 hours prior to application of traffic paint.

3.02 APPLICATION

A. Using approved equipment, apply paint to a minimum thickness of 15 mils. Stripes shall be 4" wide. Marking edges of stripes and symbols shall be sharply outlined.

END OF SECTION

SECTION 32 19 00

WALK, ROAD, AND PARKING APPURTENANCES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 WORK INCLUDED

B . Provide and install handicapped parking signs and traffic directional signs.

1.03 REFERENCES

A.. American Society for Testing and Materials (ASTM):
1. ASTM A 591 Steel Sheet, Cold-Rolled, Electrolytic Zinc- Coated.
2. ASTM B 209 Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C 33 Concrete Aggregates
4. ASTM C 150 Portland Cement

B. Military Specifications (Mil. Spec.):
1. Mil. Spec. MIL-R-13689A

1.04 SUBMITTALS

A. Product Data: Submit in accordance with SECTION 01 33 23 - SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Include catalog, cuts of each type of sign and manufacturer's installation instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle signs in accordance with SECTION 01 65 00 – PRODUCT DELIVERY REQUIREMENTS and SECTION 01 66 00- PRODUCT STORAGE AND HANDLING REQUIREMENTS and in manufacturer's cartons. Store off ground on planking. Cover with non-staining plastic.

1.06 PROJECT CONDITIONS

A. Coordinate installation of signs with work of other trades.

B. Location of signs shall be in accordance with City and State requirements. Signs shall be positioned not to conflict with automobile or pedestrian traffic.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Site signs: As manufactured by Sa-So (Sargent-Sowell, Inc.) 1185 108th Street, Grand Prairie, Texas 75050 (phone 647-1525), or approved equivalent.

2.02 MATERIALS

A. Sign Materials: Aluminum Sheets: ASTM B 209, alloy 6061 T6, degreased and etched, 0.080" thickness. Sign faces shall be fully reflectorized with material conforming to Mil. Spec. MIL-R-13689A.

B. Bolts, Nuts, Washers, and Clamps: Cadmium or galvanized steel. Bolts shall be a minimum of 5/16" in diameter. Clamps shall be two-piece assemblies of at last 14-gage steel or shall be an adjustable steel strap bracket.

C. Posts: Standard galvanized steel pipe 2-3/8" in diameter and weighing not less than 2 lbs. per linear foot.

D. Concrete: Provide concrete consisting of Portland cement (ASTM C 150), aggregates (ASTM C 33), and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 3000 psi, using at least 4 sacks of cement per cubic yard, 1 inch maximum size aggregate, maximum 3" slump, and 2% to 4% entrained air.

2.03 SITE SIGNS

A. General: Site signs shall be of the quality manufactured by Sa-So and are listed by Sa-So catalog numbers for convenience in identification.

B. Accessible Parking Signs: Reflective .080 Aluminum.

C. Accessible Loading Zone Sign: Reflective .080 Aluminum.

C. Traffic Signs:
1. ONE WAY Signs: Reflective sheeting on 0.080" aluminum.
2. ONE WAY - DO NOT ENTER Signs: Reflective sheeting on 0.080" aluminum.
3. STOP Signs: Reflective sheeting on 0.080" aluminum.

2.04 WHEEL STOPS

A. Anchor each unit with minimum of two 12” long x 1/2” diameter steel rods, through unit into pavement.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Excavation: Drill holes of the size indicated for posts. Excavate holes to the depths indicated. Remove excess concrete and excavated soil from the site.

B. Setting Posts:
1. Remove all loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete. Center and align posts in holes.
2. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations. Trowel finish tops of footings, and slope or dome to direct water away from posts.

C. Attach signs to posts with bolts, washers, nuts and clamps.

D. Clean exposed sign faces and galvanized surfaces, and leave free of defects. Use no abrasives. leave pavement and graded area clean and free of debris.

END OF SECTION

SECTION 32 31 15

VINYL-CLAD CHAIN LINK FENCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary Conditions of the Contract, Division 1 – General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SCOPE

A . Provide materials, equipment and labor to install vinyl clad chain link fencing and gates. Contractor shall obtain chain link fences as complete units, including necessary erection accessories, fittings and fastenings from a single source or manufacturer.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM A 153 – Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A 392 – Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
3. ASTM A 446 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
4. ASTM A 569 – Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality.
5. ASTM A 641 – Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
6. ASTM A 824 – Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
7. ASTM C 33 – Specification for Concrete Aggregates.
8. ASTM C 150 – Specification for Portland Cement.
9. ASTM F 567 – Practice for Installation of Chain-Link Fence.
10. ASTM F 669 – Specification for Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence.
11. ASTM F 900 – Specification for Industrial and Commercial Swing Gates.
12. ASTM F 1083 – Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
13. ASTM F 1664-08 – Specification for Poly (Vinyl Chloride) (PVC) wand other conforming Organic Polymer-Coated Steel Tension Wire used with Chain-Link Fence
14. ASTM F 2631-07 – Specification for Standard Practice for Installation of Chain- Link Fences for Outdoor Sports Fields, Sports Courts and Other Recreation Facilities

B. Chain Link Fence Manufacturer's Institute (CLFMI) Publications:
1. Product Manual

1.04 SUBMITTALS

A. Product Data: Submit all shop drawings to Engineer for review.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Provide chain link fences and gates as manufactured by one of the following:

Allied Tube and Conduit Corp.	Capitol Wire and Fence Co., Inc.
American Chain Link Fence Company	Century Tube Corp.
American Tube Company	Cyclone Fence Div./USX Corp.
Anchor Fence, Inc.	

2.02 MATERIALS

A. Steel Fabric: Comply with Chain Link Fence Manufacturers Institute (CLFMI) Product Manual. Furnish one-piece fabric widths for fencing up to 12' high. All fencing shall have a knuckled selvage top and twisted/barbed salvage along bottom. Wire size includes zinc coating. The chain link fabric shall be 9 gauge outside finish with 11 gauge galvanized steel core, vinyl clad both selvages knuckled. Color as selected by Engineer.

B. Framing: Strength requirements for posts and rails shall comply with ASTM F 669.

C. Pipe shall be straight, true to section, material and sizes specified on plans:

NPS in Inches	Outside Diameter (OD) in inches	Type I Steel (lbs./ft.)
1 ¼	1.660	2.27
1 ½	1.900	2.72
2	2.375	3.65
2 ½	2.875	5.79
3 ½	4.000	9.11
6 ⅝	6.625	18.97

D. Steel Framework, General: Posts, rails, braces and gate frames.
1. Type I Pipe: Hot-dipped galvanized steel pipe conforming to ASTM F 1083, plain ends, standard weight (schedule 40) with not less than 1.8 oz. zinc per sq. ft. of surface area coated and vinyl covered. Color as selected by Engineer.

E. End, corner and pull posts: Size as indicated on the plans.

F. Line or intermediate posts: Size as indicated on the plans.

G. Top Rail: Manufacturer's longest lengths, with expansion-type couplings, approximately 6" long, for each joint. Provide means for attaching top rail securely to each gate corner, pull and end post.
1. Size as indicated on the plans. Color as selected by Engineer.

H. Tension Wire: ASTM A 824, 0.177" diameter metallic-coated steel marcelled tension wire, vinyl clad. Color as selected by Engineer.

I. Tie Wires: 0.148-inch diameter (9 gauge - minimum) galvanized steel or equal, vinyl-clad. Color as selected by Engineer.

J. Post and Line Caps: Provide weathertight closure cap for each post. Provide line post caps with loop to receive tension wire or top rail. Vinyl-clad and color to be selected by Engineer.

K. Tension or Stretcher Bars: Hot-dip galvanized steel vinyl clad with minimum length 2" less than full height of fabric, minimum cross-section of 3/16" by ¾" and minimum 1.2 oz. zinc coating per sq. ft. of surface area. Provide one bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into post. Color to be selected by Engineer.

L. Tension and Brace Bands: Minimum ¾" wide hot-dip galvanized steel vinyl clad with minimum 1.2 oz. zinc coating per sq. ft. of surface area. Color to be selected by Engineer.
1. Tension and Brace Bands: Minimum 12 gauge (0.105") thick.

M. Gates:
1. Gate frames shall be constructed of 2" o.d., Schedule 40 steel pipe secured at corners with malleable iron or pressed steel ells, riveted with four rivets per ell. Frame shall be hot-dip zinc coated after fabrication and vinyl-clad. Color to be selected by Engineer.
2. Welded gate frames are unacceptable.

3. Internal bracing shall be 3/8" diameter galvanized truss rods with tighteners.
4. Hinges shall be pressed steel or malleable iron. Bottom hinge shall be a ball and socket type. All gates shall allow for a one hundred eight (180˚) degree swing.
5. Gates shall be equipped with a heavy duty fork-type latch with lock keeper and lock keeper guide and as indicated on the plans.

N. Fittings: All fittings to be hot-dip zinc coated vinyl covered shall be 1.2 ounces of zinc per square foot of coated area. Color to be selected by Engineer.

O. Concrete Post Footings shall be as specified per plans and per manufacturer's recommendations.

PART 3 - EXECUTION

3.03 INSTALLATION

A. General: Install fence in compliance with ASTM F 567. Do not begin installation and erection before final grading is completed.

B. Setting Posts: Center and align posts in holes 6" above bottom of excavation. Space maximum 8' o.c. unless otherwise noted on the plans. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations. Extend concrete footings 2" above grade and trowel to a crown to shed water.

C. Top Rails: Run rail continuously through line post caps, bending to radius for curved runs and at other posts terminating into rail end attached to posts or post caps fabricated to receive rail. Provide expansion couplings as recommended by fencing manufacturer.

D. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.

E. Bottom Tension Wire: Install tension wire within 6" of bottom of fabric before stretching fabric and tie to each post with not less than same gage and type of wire. Pull wire taut, without sags. Fasten fabric to tension wire with 11-gauge hog rings of same material and finish as fabric wire, spaced maximum 24" o.c.

F. Tension or Stretcher Bars: Thread through or clamp to fabric 4" o.c., and secure to end, corner, pull and gate posts with tension bands spaced not over 15" o.c.

G. Tie Wires: Use U-shaped wire of proper length to secure fabric firmly to posts and rails with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.
1. Maximum Spacing: Tie fabric to line posts 12" o.c. and to rails and braces 24" o.c.

H. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

I. Fabric: All fabric shall be placed on the inside of school facility.

END OF SECTION

SECTION 32 8400

PLANTING IRRIGATION

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

The requirements of the "General Conditions of the Contract" and of Division 1, "General Requirements", shall apply to all work of this Section with the same force and effect as though repeated in full herein.

1.02 SCOPE OF WORK

A. Provide all labor, materials, transportation, and services necessary to furnish and install Irrigation Systems as shown on the drawings and described herein.

B. Related work in other sections:

1. 32 92 13 HYDROMULCHING
2. 32 92 23 SOD
3. 32 93 00 TREES, SHRUBS, AND GROUNDCOVERS

C. The term of "LICENSED IRRIGATOR" shall refer to Teague Nall and Perkins, Inc., 5237 N. Riverside Drive, Suite 100, Fort Worth, Texas 76137.

1.03 QUALITY ASSURANCE & REQUIREMENTS

A. Permits and Fees: The Contractor shall obtain and pay for any and all permits and all observations as required.

B. Manufacturer's Directions: Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturers of articles used in this contract furnish directions covering points not shown in the drawings and specifications

C. Ordinances and Regulations: All local, municipal, and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and make a part of these specifications, and their provisions shall be carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations or requirements of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.

D. Explanation of Drawings:
1. Due to the scale of drawings, it is not possible to indicate all offsets, fittings, sleeves, etc., which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc., as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such a manner as to avoid conflicts between irrigation systems, planting, and architectural features.
2. All work called for on the drawings by notes or details shall be furnished and installed whether or not specifically mentioned in the specifications.
3. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in

engineering. Such obstructions or differences should be brought to the attention of the Licensed Irrigator immediately. In the event this notification is not performed, the Irrigation Contractor shall assume full responsibility for any revision necessary.

1.04 SUBMITTALS

A. Material List:
1. The Contractor shall furnish the articles, equipment, or processes specified by name in the drawings and specifications. No substitution will be allowed without prior written approval by the Licensed Irrigator.
2. Complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, model number, and description of all materials and equipment to be used.
3. Equipment or materials installed or furnished without prior approval of the Licensed Irrigator may be subject to rejection, and the Contractor required to remove such materials from the site at his own expense.
4. Approval of any item, alternate, or substitute indicates only that the product or products apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted.
5. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.

B. Record and As-Built Drawings:
1. The Contractor shall provide and keep an up-to-date and complete "as-built" record set of blue line ozalid prints which shall be corrected daily and show every change from the original drawings and specifications, the exact "as-built" locations, sizes, and kinds of equipment. Prints for these purposes may be obtained from the Licensed Irrigator at cost. This set of drawings shall be kept on the site and shall be used only as a record set.
2. These drawings shall also serve as work progress sheets and shall be the basis for measurement and payment for work completed. These drawings shall be available at all times for inspection and shall be kept in a location designated by the Licensed Irrigator. Should the record blue line as-built progress sheets not be available for review or not up-to-date at the time of any inspection (refer to Section 3.09 - Observation Schedule), it will be assumed no work has been completed and the Contractor will be assessed the cost of that site visit at the current billing rate of the Licensed Irrigator. No other observations shall take place prior to payment of that assessment.
3. The Contractor shall make neat and legible notations on the as-built progress sheets daily as the work proceeds, showing the work as actually installed. For example, should a piece of equipment be installed in a location that does not match the plan, the Contractor must indicate that equipment has been relocated in a graphic manner so as to match the original symbols as indicated in the irrigation legend. The relocated equipment and dimensions will then be transferred to the original as-built plan at the proper time.
4. Hand drawn: In lieu of electronically drawn, before the date of the final inspection, the Contractor shall transfer all information from the "as-built" prints to a sepia Mylar, or similar Mylar material, procured from the Licensed Irrigator. All work shall be in waterproof India ink and applied to the Mylar be a technical pen made expressly for use on Mylar material. Such pen shall be similar to those manufactured by Rapidograph, Kueffell & Esser, or Faber Castell. The dimensions shall be made so as to be easily readable, even on the final controller chart (see Section C). The original Mylar "as-built" plan shall be submitted to the Licensed Irrigator for approval prior to the making of the controller chart.
5. Electronically drawn: In lieu of hand drawn, before the date of the final inspection, the Contractor shall transfer all information from the "as-built" prints to an AutoCAD

electronic file procured from the Licensed Irrigator. All work shall be documented on a unique and separate layer. The electronically drawn "as-built" plan shall be submitted to the Licensed Irrigator for approval prior to the making of the controller chart.

6. The Contractor shall dimension from two (2) permanent points of reference - building corners, sidewalks, road intersections, etc. - the location of the following items:
   a. Connection to existing water lines
   b. Connection to existing electrical power
   c. Gate valves
   d. Routing of irrigation pressure lines (dimension maximum 100' along routing).
   e. Irrigation control valves.
   f. Routing of control wiring.
   g. Quick coupling valves.
   h. Road and sidewalk borings. With a small masonary blade label each sleeve location with an “S” cut directly above all sleeve ends.
   i. Other related equipment as directed by the Licensed Irrigator

7. On or before the date of the final inspection, the Contractor shall deliver the corrected and completed sepias to the Licensed Irrigator. Delivery of the sepias will not relieve the Contractor of the responsibility of furnishing required information that maybe omitted from the prints.

C. Controller Charts:
1. As-built drawings shall be approved by the Licensed Irrigator before controller charts are prepared.
2. Provide on (1) controller chart for each controller supplied.
3. The chart shall show the area controlled by the automatic controller and any area under a manual irrigation. The chart shall be the maximum size which the controller door will allow.
4. The chart is to be a reduced drawing of the actual as-built system. However, in the event the controller sequence is not legible when the drawing(s) is reduced, it shall be enlarged to a size that will be readable when reduced.
5. The chart shall be a black line or blue line ozalid print. A different color shall be used to indicate the area of coverage for each station.
6. When completed and approved, the chart will be hermetically sealed between two (2) pieces of plastic, each piece being a minimum 10 mils thickness.
7. These charts shall be completed and approved prior to final inspection of the irrigation system.

D. Operation and Maintenance Manuals:
1. Prepare and deliver to the Licensed Irrigator within ten (10) calendar days prior to completion of construction, two (2) hard cover binders with three (3) rings containing the followings information:
   a. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturer's representative
   b. Catalog and parts sheets on every material and equipment installed under this contract.
   c. Guarantee statement.
   d. Complete operating and maintenance instructions on all major equipment, i.e. the automatic controller(s).
2. In addition to the above mentioned maintenance manuals, provide the Licensed Irrigator with instructions for major equipment and show evidence, in writing, to the

Licensed Irrigator at the conclusion of the project that this service has been rendered.

E. Equipment to be Furnished:
   1. Supply as a part of this Contract the following tools:

      a. Two (2) sets of special tools required for removing, disassembling and adjusting each type of irrigation head and valve supplied on this project.
      b. Two (2) five foot valve keys for operation of the ball and remote control valves.
      c. Two (2) keys for each automatic controller.
      d. One (1) quick coupler key and matching hose swivel ell for every five (5), or fraction thereof, of each type of quick coupling valve installed.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handling of PVC Pipe and Fittings: The Contractor is cautioned to exercise care in handling, loading, unloading, and storing of PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been damaged will be discarded and, if installed, shall be replaced with new piping.

1.06 SUBSTITUTIONS

A. If the Contractor wishes to substitute any equipment or materials for those equipment or materials listed on the drawings and specifications, he may do so by providing the following information to the Licensed Irrigator for approval:
   1. Provide a statement indicating the reason for making the substitution. Use a separate sheet of paper for each item to be substituted.
   2. Provide descriptive catalog literature, performance charts, and flow charts for each item to be substituted.
   3. Provide the amount of cost savings if the substituted item is approved.

B. The Licensed Irrigator shall have the sole responsibility in accepting or rejecting any substituted item as an approved equal to those equipment and materials listed on the irrigation drawings and specifications

1.07 GUARANTEE

A. The guarantee for the planting irrigation system shall be made in accordance with the attached form. The general conditions and supplementary conditions of these specifications shall be filed with the Owner and the Licensed Irrigator prior to acceptance of the irrigation system.

B. A copy of the guarantee form shall be included in the operations and maintenance manual.

C. The guarantee form shall be re-typed onto the Contractor's letterhead and contain the following information:

ONE-YEAR WARRANTY & GUARANTEE FOR PLANTING IRRIGATION SYSTEM

We hereby guarantee that the planting irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the drawings and specifications, ordinary wear and tear and unusual abuse, or neglect excepted. We agree to repair or replace any defects in material or workmanship which may develop to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner for a period of one year after final acceptance of the project. We shall make such repairs or replacements within a reasonable time, as determined by the Owner, after receipt of written notice. In the event of our failure to make such repairs or replacement within a reasonable time after receipt of written notice from the Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefore upon demand.

PROJECT: _____

LOCATION: _____

_____

SIGNED: _____

COMPANY: _____

ADDRESS: _____

_____

_____

PHONE: (_____) _____ - _____

DATE OF ACCEPTANCE: _____ / _____ / _____

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Use only new materials of brands and types noted on drawings, specified herein, or approved equals.

B. PVC pressure main line pipe and fittings:
   1. Pressure main line piping for sizes 3" and larger shall be PVC Class 200 with o-ring gasket joints. All tees, ells and other fitting shall be solvent welded.
   2. Pressure main line piping for sizes 2 1/2" and smaller shall be PVC Class 200 with solvent welded joints.
   3. Pipe shall be make from NSF approved Type I, Grade II PVC compound conforming to ASTM resin specification D1784. All pipes must meet requirements as set forth in Federal Specification PS-22-70.
   4. PVC solvent-weld fittings shall be Schedule 40, 1-2, II-I NSF approved conforming to ASTM test procedure D2466. All male adapters shall be SCH 80 PVC.
   5. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation methods prescribed by the manufacturer.
   6. All PVC pipe must bear the following markings:
      a. Manufacturer's name
      b. Nominal pipe size
      c. Schedule or class
      d. Pressure rating in P.S.I.
      e. NSF (National Sanitation Foundation) approval
      f. Date of extrusion
   7. All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable I.P.S. schedule and NSF seal of approval.

C. PVC Non-Pressure Lateral Line Piping:
   1. Non-pressure buried lateral line piping shall be PVC class 200 with solvent-weld joints.
   2. Pipe shall be made from NSF approved, Type I, Grade II PVC compound to ASTM resin specification D1784. All pipes must meet requirements set forth in Federal Specification PS-22-70 with an appropriate standard dimension ratio.
   3. Except as noted in paragraphs 1 and 2 of Section 2.01B, all requirements for non-pressure lateral line pipe and fittings shall be the same as for solvent-weld pressure main line pipe and fittings as set forth in Section 2.01B of these specifications.

D. Copper Piping and Fittings:
   1. Copper piping shall be type "K" hard-drawn with "sweat" type fittings.
   2. Pipe and fittings shall be assembled with 50/50 soft solder and non-erosive flux. Solder shall take up capillary action and joints shall be made tight without build-up head.
   3. Pipe ends shall be squared, reamed to remove burrs, and cleaned bright with fine sandpaper and steel wool.

E. Ball Valves:
   1. Ball valves 3" and smaller shall be similar to those manufactured by Lasco, or approved equal.
   2. Ball valves 3" and smaller shall have threaded ends shall be equipped with a hand lever.
   3. All ball valves shall be installed per installation detail and the manufacturer's recommendations.

F. Quick Coupling Valves: Quick coupling valves shall have a brass two-piece body designed for working pressure of 150 p.s.i. operable with quick coupler. Key size and type shall be as shown on the plans.

G. Backflow Prevention Units:
   1. Backflow prevention units shall be of size and type indicated on the drawings. Install backflow prevention units in accordance with irrigation construction details.
   2. Wye strainers at backflow prevention units shall have a bronzed, screwed body with 60 mesh monel screen and shall be similar to Bailey #100B, or approved equal. Mount wye stainers sideways so they are easier to service.

H. Automatic Drain Valves:
   1. Automatic drain valves shall be plunger type, duty virgin PVC construction, with small thread inlet.
   2. Drain valve shall be installed at an angle of 30 to 45 degrees horizontal, in a direction to facilitate pipe drainage.
   3. Provide sump pit for drainage.

I. Control Wiring:
   1. Connections between the automatic controllers and the electric control valves shall be made with direct burial copper wire, AWG-U.F. 600 volt.
   2. Pilot wires shall be a different color wire for each automatic controller.
   3. Common wires shall be white with a different color stripe for each automatic controller.
   4. Install in accordance with valve manufacturer's specifications and wire chart. In no case shall the wire size be less than #12 gauge.
   5. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible.
   6. Where more than one (1) wire in placed in a trench, the wiring shall be taped together at intervals of ten (10) feet.
   7. An expansion curl shall be provided within three (3) feet of each wire connection. Expansion curl shall be of sufficient length at each splice connection at each electric remote control valve, so that in case of repair, the valve bonnet may be brought to the surface without disconnecting the control wires. Control wires shall be laid loosely in the trench without stress or stretching of control wire conductors.
   8. All splices shall be made with Scotch-Lok #3576 Connector Sealing Packs, Rain Bird Snap-Tite wire connector, or approved equal. Use one (1) splice per connector sealing pack.
   9. Field splices between the automatic controller and electrical control valves will not be allowed without prior approval of the Licensed Irrigator. All approved field splices shall be placed in a Control Valve Box and labeled appropriately.

J. Automatic Controllers:
   1. Automatic controllers shall be of size and type shown on the plans.
   2. Final location of the automatic controller shall be approved by the Licensed Irrigator.
   3. Unless otherwise noted on the plans, the 120 volt electrical power to each automatic controller location shall be furnished by the Contractor. The final electrical hook-up shall be the responsibility of the Contractor.

K. Electrical Control Valves:
   1. All electric control valves do not have to be the same manufacture as the automatic controller.
   2. All electric control valves shall have a manual flow adjustment.
   3. Furnish and install one (1) control valve box for each electric control valve.

L. Control Valve Boxes:
   1. Use 10" round box for all field splices, Oldcastle Enclosure Solutions Model 910 with green cover, or approved equal. Extension sleeves shall be 6" PVC minimum size.
   2. Use 14" X 19" standard rectangular box for all gate valves and quick coupler valves, Oldcastle Enclosure Solutions Model 1419 with green, “Drop-N-Lock” lid cover, or approved equal. Extension sleeves shall be 6" PVC minimum size.

3. Use 13" X 24" jumbo rectangular box for all electric control valves, Oldcastle Enclosure Solutions Model 1324 with green, “Drop-N-Lock” lid cover, or approved equal. Extension sleeves shall be 6" PVC minimum size.

M. Irrigation Heads:
1. All irrigation heads shall be of the same size, type, and deliver the same rate of precipitation with the diameter (or radius) of throw, pressure, and discharge as shown on the drawings, or specified in these special provisions.
2. Spray heads shall have a screw adjustment.
3. Riser units shall be fabricated in accordance with the details shown on the plans.
4. Riser nipples for all irrigation heads shall be the same size as the riser opening in the irrigation body.
5. All irrigation heads of the same type shall be of the same manufacture.

PART 3 - EXECUTION

3.01 INSPECTION

A. Site Conditions:
1. All scaled dimensions are approximate. The Contractor shall check and verify all size dimensions and receive the Licensed Irrigator's approval prior to proceeding with work under this section.
2. Exercise extreme care in excavating and working near existing utilities. The Contractor shall be responsible for damages to utilities which are caused by his operations or neglect. Check existing utilities drawings for existing utility locations.
3. Coordinate installation of planting irrigation materials including pipe, so there shall be NO interference with utilities or other construction or difficulty in planting trees, shrubs, and ground covers.
4. The Contractor shall carefully check all grades to satisfy himself that he may safely proceed before starting work on the planting irrigation system.

3.02 PREPARATION

A. Physical Layout:
1. Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of irrigation heads.
2. All layout shall be approved by the Licensed Irrigator prior to installation.

B. Water Supply:
1. Planting irrigation system shall be connected to water supply points of connection as indicated on the drawings.
2. Connections shall be made at approximate locations as shown on the drawings. The Contractor is responsible for minor changes caused by actual site conditions.
3. The point of connection shall be as shown on the drawings and shall be furnished by the Contractor, unless otherwise specified.

C. Electrical Supply:
1. Electrical connections for the automatic controller shall be made to electrical points of connection as indicated on the drawings.
2. Connections shall be made at approximate locations, as shown on the drawings. The Contractor is responsible for minor changes caused by actual site conditions.

3.03 INSTALLATION

A. Trenching:

1. Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow layout indicated on the drawings, and as noted.
2. Provide for a minimum of eighteen (18) inches cover for all pressure supply lines.
3. Provide for a minimum cover of twelve (12) inches for all non-pressure lines.
4. Provide for a minimum cover of eighteen (18) inches for all control wiring.

B. Backfilling:
1. The trenches shall be backfilled a maximum of 50% with all joints exposed until all required tests are performed. Trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted landscaped areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill will conform to adjacent grades without dips, sunken areas, humps, or other surface irregularities.
2. A fine granular material backfill will be initially placed on all lines. No foreign matter larger than one-half (1/2) inch in size will be permitted in the initial backfill.
3. Flooding of trenches will always be permitted and preferred.
4. If settlement occurs and subsequent adjustments in pipe, valves, irrigation heads, lawn or planting, or other construction are necessary, the Contractor shall make all required adjustments without cost to the Owner.

C. Trenching and Backfill Under Paving:
1. Trenches located under areas where paving, asphaltic concrete or concrete, will be installed shall be backfilled with sand (a layer of six [6] inches below the pipe and three [3] inches above the pipe) and compacted in layers to 95% standard proctor, using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and shall be left in a firm, unyielding condition. All trenches shall be left flush with the adjoining grade. The Contractor shall set in place, cap, and pressure test all piping under paving prior to the paving work.
2. Generally piping under existing walks is done by jacking, boring, or hydraulic driving, but where any cutting or breaking of sidewalks or concrete is necessary, it shall be done and replaced by the Contractor as part of the contract cost, to the satisfaction of the Licensed Irrigator. Permission to cut or break sidewalks or concrete shall be obtained from the Licensed Irrigator. NO hydraulic driving will be permitted under concrete paving.
3. Provide for a minimum cover of eighteen (18) inches between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete paving.

D. Assemblies:
1. Routing of planting irrigation lines as indicated on the drawings is diagrammatic. Install lines (and various assemblies) in such a manner as to conform to the details per plans.
2. Install NO multiple assemblies in plastic lines. Provide each assembly with its own outlet.
3. Install all assemblies specified herein in accordance with the respective detail. In the absence of detail drawings or specifications pertaining to specific items required to complete the work, perform such work in accordance with the best standard practice, with the approval of the Licensed Irrigator.
4. PVC pipe and fittings shall be thoroughly cleaned of dirt, dust, and moisture before the installation. Installation and solvent welding methods shall be as recommended by the pipe and fitting manufacturer.
5. On PVC to metal connections, the Contractor shall work the metal connections first. Teflon tape, or approved equal, shall be used on all threaded PVC to PVC, and on all threaded PVC to metal joints. Light wrench pressure is all that is required. Where threaded PVC connections are required, use threaded PVC adapters into which the pipe may be welded.

E. Line Clearance: All lines shall have a minimum clearance of six (6) inches from each other and from lines of other trades. Parallel lines shall not be installed directly over one another.

F. Automatic Controller: Install the automatic controller(s) in accordance with the manufacturer's instructions. Remote control valves shall be connected to the controller in the numerical sequence as shown on the drawings.

G. High Voltage Wiring for Automatic Controller:
   1. 120 volt electrical service for the automatic controller shall be the responsibility of the Contractor. The Contractor shall be responsible for permitting and getting the electrical utility service company to install the appropriate electrical service and meter base necessary to operate each automatic controller. The final location of the electrical meter base shall be approved by the Licensed Irrigator.
   2. 120 volt electrical service connection to the automatic controller shall be provided by the Contractor.
   3. All electrical work shall conform to local codes, ordinances, and union authorities having jurisdiction.

H. Remote Control Valves: Install remote control valves where shown on the drawings and per the detail. When valves are grouped together, allow at least thirty-six (36) inches between valves. Install each remote control valve in a separate valve box. Each valve number (per the drawings) shall be stenciled on the valve box lid with exterior paint. Paint color shall be flat black. Stencil number size shall be 3" in height. Additionally, on each valve install a waterproof tag with the valve number legibly written. Afix to the valve using plastic tie or galvenized wire that will not impede the manual operation of the valve.

I. Ball Valves: Install ball valves where shown on the drawings and per the detail. When valves are grouped together, allow at least thirty-six (36) inches between valves. Install each ball valve in a separate valve box. Each ball valve shall have stenciled on the valve box lid, "BV" with exterior paint. Paint color shall be flat black. Stencil letter size shall be 3" in height.

J. Quick Coupler Valves: Install where shown on the drawings and per the detail. Install each quick coupler valve in a separate valve box. Each quick coupler valve shall have stenciled on the valve box lid, "QC" with exterior paint. Paint color shall be flat black. Stencil letter size shall be 3" in height.

K. Flushing of the System:
   1. After all new irrigation pipe lines and risers are in place and connected, all necessary diversion work has been completed, and prior to installation of the irrigation heads, the control valves shall be opened and full head of water used to flush out the system.
   2. Irrigation heads shall be installed only after flushing of the system has been accomplished to the complete satisfaction of the Licensed Irrigator.

L. Irrigation Heads:
   1. Install the irrigation heads as designated on the drawings. Irrigation heads to be installed in this work shall be equivalent in all respects to those itemized.
   2. Spacing of heads shall not exceed the maximum indicated on the drawings. In NO case shall the spacing exceed the maximum recommended by the manufacturer.

M. Field Splices: Install field splices of control valve wiring in a valve box (see Section 2.01 L.1). Each field splice valve box lid shall have stenciled "Field Splice" on it with exterior paint. Paint color shall be flat black. Stencil letter shall be 3" in height.

3.04 TEMPORARY REPAIRS

A. The Owner reserves the right to make temporary repairs as necessary to keep the irrigation system equipment in operating condition. The exercise of this right by the Owner shall not relieve the Contractor of his responsibilities under the terms of the guarantee as herein specified.

3.05 FIELD QUALITY CONTROL

B. Adjustment of the System:
   1. The Contractor shall flush and adjust all irrigation heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible.
   2. If it is determined by the Licensed Irrigator that adjustments in the irrigation equipment will provide proper and more adequate coverage, the Contractor shall make such adjustments prior to planting. Adjustments may also include changes in nozzle sizes and degrees of arc as required.
   3. Lowering raised irrigation heads by the Contractor shall be accomplished within ten (10) calendar days after notification by the Licensed Irrigator.
   4. All irrigation heads shall be set perpendicular to finished grades unless otherwise designated on the drawings.

C. Testing of Irrigation System:
   1. The Contractor shall request the presence of the Licensed Irrigator, in writing, at least 24 hours in advance of the testing.
   2. Test all pressure lines under hydrostatic pressure of 150 pounds per square inch, and prove watertight. Note that the testing of pressure main lines shall occur prior to installation of the electric remote control valves.
   3. All piping under paved areas shall be tested under hydrostatic pressured of 150 pounds per square inch, and proved watertight, prior to paving.
   4. Sustain pressure in lines for not less than eight (8) hours. If leaks develop, replace joints and repeat the test until the entire system is proven watertight.
   5. All hydrostatic tests shall be made only in the presence of the Licensed Irrigator. NO pipe shall be completely backfilled until it has been inspected, tested, and approved in writing.
   6. Furnish necessary force pump and all other test equipment.
   7. When the planting irrigation system is completed, perform a coverage test in the presence of the Licensed Irrigator, to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from plans, or where the system has been willfully installed, as indicated on the drawings, when it is obviously inadequate, without bringing this to the attention of the Licensed Irrigator. This test shall be accomplished before any ground cover is planted.
   8. Upon completion of each phase of work, the entire system shall be tested and adjusted to meet site requirements.

3.06 MAINTENANCE

A. The entire planting irrigation system shall be under full automatic operation for a period of seven (7) calendar days prior to any planting.
B. The Licensed Irrigator reserves the right to waive or shorten the operation period.

3.07 CLEAN-UP

Clean-up shall be made daily as each portion of the work progresses. Refuse and excess dirt shall be removed, all walks and paving shall be broomed or washed down, and any damage sustained on the work of others shall be repaired to the original condition.

3.08 FINAL OBSERVATION PRIOR TO ACCEPTANCE

A. The Contractor shall operate each system in its entirety for the Licensed Irrigator, at the time of the final observation. Any items deemed not acceptable by the Licensed Irrigator shall be re-worked to the complete satisfaction of the Licensed Irrigator.

B. The Contractor shall show evidence to the Licensed Irrigator that the Owner has received all accessories, charts, record drawings, and equipment as required before final inspection can occur.

3.09 OBSERVATION SCHEDULE

A. The Contractor shall be responsible for notifying the Licensed Irrigator, in advance, for the following observation meetings, according to the time indicated:
   1. Pre-Job Conference - 7 days.
   2. Pressure supply line installation & testing - 48 hours
   3. Automatic controller installation - 48 hours
   4. Control wire installation - 48 hours
   5. Lateral line and irrigation installation - 48 hours
   6. Coverage test - 48 hours
   7. Final inspection - 7 days

B. When observations have been conducted by other than the Licensed Irrigator, show evidence, in writing, of when and by whom these observations were made.

C. NO site observations will commence without as-built drawings. In the event the Contractor calls for a site visit without as-built drawings, without completing previously noted corrections, or without preparing the system for the said visit, he shall be responsible for reimbursing the Licensed Irrigator at his current billing rates per hour, portal to portal (plus transportation costs) for the inconvenience. NO further site visits will be scheduled until this charge has been paid and received.

END OF SECTION

SECTION 32 9223

HYDROMULCHING

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

The requirements of the "General Conditions of the Contract" shall apply to all work of this Section with the same force and effect as though repeated in full herein.

1.02 SCOPE OF WORK

A. Furnish all labor, material, equipment, and services necessary to provide all landscape hydro-seeding work, complete in place, as shown on the drawings and as specified.

B. Work specified in this Section: The work includes, but is not necessarily limited to:
1. Soil preparation
2. Fine grading
3. Seeding via Hydrosprayer (A slurry of seed, fertilizer, water, tackifiers, biologically active soil conditioners, a color dye, and organic mulch fibers)
4. Clean-up
5. Maintenance

C. Related work in other Sections:
1. 32 8400 PLANTING IRRIGATION
2. 32 9300 TREES, SHRUBS, AND GROUNDCOVERS
3. 32 9223 SOD

D. Definition: The term of "Landscape Architect" shall refer to Teague Nall and Perkins, Inc., 5237 N. Riverside Drive, Suite 100, Fort Worth, Texas 76137.

E. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
1. American Society for Testing and Materials (ASTM): D 1557 Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 10 lb. (4.54 kg) Rammer and 18 in. (457mm) Drop.

1.03 SUBMITTALS

A. Samples and Product Information: Representative samples or product information of the following materials shall be provided to the Landscape Architect from the supply source that is to be used for turf seeded areas and native wildflower or native grass seeded areas:
1. Topsoil
2. Soil Amendments
3. Fertilizer: specifications and guaranteed analysis.
4. Biological Amendments: ingredients, chemical analysis, and manufacturer.
5. Seed type and purity analysis. Save labels for field inspection by LA.
6. Tackifier material components and manufacturer.
7. Hydromulch manufacture and type of mulch to be used.

B. Construction Schedule: At least two weeks prior to start of work, submit seeding schedule.

C. Maintenance: Submit three copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of the lawns for an entire year. Submit prior to Notice of Substantial Completion. See Section 3.10, 90 DAY MAINTENANCE

D. Chemicals: Submit products, rates of application, and anticipated uses of any pesticides, herbicides, and fumigants.

1.04 QUALITY ASSURANCE

A. Contractor's Qualifications
   1. The work of this section shall be performed by a Contractor specializing in hydro-seeding.
   2. The Contractor shall have successfully completed at least 5 installations of this type, size, and complexity in the last four years.

B. Materials shall comply with all government regulations prevailing at the supply source and the job site.

C. Fertilizers; Mixed Commercial. Federal Specification: 0-F-241D

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handling and Storage of Seed: Seed shall be kept dark, cool (between 40-50 degrees F), and dry until time of planting.

1.06 JOB CONDITIONS

A. Do not install seed on saturated, excessively dry, or frozen soil.

B. Seed installation shall be subject to suitability of the weather and other conditions affecting seed germination.

C. Planting season may be extended only with the written permission of the Landscape Architect.

1.07 SAMPLES AND TESTS

A. The Landscape Architect reserves the right to take and analyze samples of materials for conformity to specifications at any time. The Contractor shall furnish samples upon request by the Landscape Architect. Rejected materials shall be immediately removed from the site at the Contractor's expense. Cost of the testing of materials not meeting specifications shall be paid by the Contractor.

B. After rough grading is complete, Contractor shall order and pay for a soil test which includes recommendations. Take a minimum of one soil test per 10 acres - or more as site conditions mandate. Take approximately 15 cores from each uniform soil area. Mix them thoroughly in a clean plastic or paper container. Fill the soil sample bag one-third to one-half full from this representative sample. Acceptable labs are:
   1. TPS Lab: “SO-05, TPSL® Plant Natural™ Soil Test + LOI Organic Matter + Solvita®”
   2. A&L Plains Agricultural Laboratories: “Basic Test S2” and “Basic Test S3” and “Organic Matter – by Combustion” (all three tests are required)

C. Submit results to Landscape Architect for adjustment to soil amendments and fertilizers.

1.08 MAINTENANCE

A. All stored plant material shall be maintained in a healthy, vigorous condition by the Contractor. Maintenance includes, but is not necessarily limited to, mowing, weeding, edging, watering, trash removal, street and gutter cleaning, erosion repair, removal of siltation in drainage areas, and insect and disease chemical applications. The storage area shall be mowed, weeded, and trimmed weekly during the course of construction and the life of the storage area.

B. Within the limits of construction, the site shall be maintained in a neat, well-kept appearance by the Contractor. Maintenance includes, but is not necessarily limited to, mowing, weeding, edging, watering, trash removal, street and gutter cleaning, erosion repair, removal of siltation in drainage areas, and insect and disease chemical applications.

C. Contractor shall maintain plant material as described in Part 3.10, 90-DAY MAINTENANCE

1.09 GUARANTEE AND REPLACEMENT

A. Warrant all hydromulched areas for a period of one year from date of Notice of Substantial Completion, to be at least the quality and conditions as at Final Acceptance. Promptly reseed bare or unacceptable areas during the warranty period as directed by the Landscape Architect.

B. Lawns shall be uniform in color, grass type, leaf texture, leaf and root density, and free from weeds, diseases, and other visible imperfections at acceptance.

C. Damage to the irrigation system by other trades or persons (such as shutting off of water or power to the irrigation system) shall not affect the warranty. This means that, especially in the warm season, the Contractor shall make daily visits to the site to inspect and repair the irrigation system up until final acceptance.

1.10 FINAL INSPECTION AND ACCEPTANCE

A. The Landscape Architect will inspect all work for Substantial Completion upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of inspection.

B. Acceptance will be based on establishment of a uniform stand of turf grass, defined as coverage of specified grass at a density of 95 percent coverage, with no bare spots greater than one square foot, free of weeds, undesirable grass species, disease, and insects. For grass varieties selected, allow a minimum of 90 days for establishment and maintenance of an acceptable strand of grass.

C. In areas that are grassed and not irrigated. An acceptable strand of grass shall be established and the Landscape Architect will inspect the work for Substantial Completion upon written request of the Contractor.

D. Upon completion and re-inspection of all repairs or renewals necessary in the judgment of the Landscape Architect, the Landscape Architect will recommend to the Owner that the work of this Section be accepted.

PART 2 - MATERIALS

2.01 HYDROMULCHING

A. Seed shall be fresh, clean, dry new crop seed tested for minimum percentages of purity and germination and label in accordance with the U.S. Department of Agriculture regulations. Seed tags shall not be more than 9 months old.
   1. Pure Live Seed (PLS) shall not be less than 90 percent.
   2. Maximum weed content shall be 0.30 percent.

B. Bermuda seed type shall be hulled certified 'Princess 77' Bermuda by Pennington Seed. Seed shall contain certified seed composed of the following PLS (by weight):
   1. Material: Permanent seed variety.
   2. Seed: Must be Certified Princess 77.
   3. Inert Material: Less than 1%.
   4. Other Crop Seed: Less than .5%.
   5. Weed Seed: Less than 1%.
   6. Coating: MYCO Advantage coated.
   7. Packaging: 25lb Plastic container

C. Rabbit Turf seed mix. Seed shall be from Browning Seed (800) 243-5271. Seed mix shall contain certified seed composed of the following PLS (by weight):
   1. 49% Buffalo Grass – 'SWI 2000'
   2. 49% Blue Grama Grass
   3. 2% Curly Mesquite

D. Mid-State Native Grass Seed Mix. Seed shall be from Browning Seed (800) 243-5271 and contain certified seed composed of the following PLS (by weight):
   1. 25% - 35% Buffalo Grass – 'SWI 2000'
   2. 15% - 25% Little Bluestem
   3. 15% - 25% Side Oats Grama
   4. 5% - 10% Bluegrama
   5. 5% - 10% Curly Mesquite
   6. 5% - 10% Sand Dropseed

E. Praire Masterpiece Seed Mix. Seed shall be from Browning Seed (800) 243-5271 and contain certified seed composed of the following PLS (by weight):
   1. 20% - 25% Buffalo Grass – 'SWI 2000'
   2. 15% - 25% Side Oats Grama
   3. 5% - 15% Little Bluestem
   4. 5% - 15% Bluegrama
   5. 4% - 8% Texas Bluebonnet
   6. 2% - 5% Indian Blanketflower
   7. 2% - 4% Black-Eyed Susan
   8. 2% - 5% Mexican Hat
   9. 2% - 5% Plains Coreopsis
   10. 2% - 5% Purple Coneflower
   11. .5% - 1% Lemon Beebalm

F. Root Inoculant: SaberEx for Wheat and Cereals by ABM (or approved equal). Apply as a dry seed treatment prior to seeding:
   1. Active Ingredient: 1.0% Trichoderma harzianum 2.5x10 7 cfu/gm
   2. Inert Ingredients: Graphite 60.0%, Cellulose 24.0%, Talc 15.0%

G. Tackifier: By Profile Products or approved equal. Tackifier shall be included in Hydromulch and factory mixed. Follow manufacturer's recommendations.

H. pH Soil Doctor: (granular humate soil amendment) from Browning Seed, Inc. (800) 243-5271, http://www.browningseed.com or approved equal, with formulation of:
1. Humic Acid 37.50%
2. Calcium (CaSo4) 10.00%
3. Sulfur (S) 7.00% (to lower pH)
4. Calcium Sulfate(CaSo4) 34.00% (Derived from quarried calcium sulfate)
5. Water Soluble Binder-lignosulfonate .50%

I. Fertilizer for Hydromulch areas: Italpollina 4-4-4 or approved equal. Product shall be an OMRI registered organic fertilizer of a guaranteed analysis, 4-4-4, containing no less than 41% total organic Carbon, 71% organic matter, and 5% humic acid. Contact: Allen Olson (817) 368-8615, allen@gdrsystems.net

J. Hydromulch: Shall be manufactured by Profile Products LLC or approved equal. Hydromulch shall be a fully biodegradable, Hydraulic Mulch composed of 100% recycled Thermally Refined wood fibers, cellulose fibers, and wetting agents (including high-viscosity colloidal polysaccharides). Hydromulch shall be phytosanitized, free from plastic netting, and upon application form an intimate bond with the soil surface to create a porous, absorbent and flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth.
1. Seeded areas less than 8:1 slope: Soil Cover Blend with Tack, by Profile Products:
   a. Thermally Refined® Wood Fibers (minimum) – 58%
   b. Cellulose Fiber (maximum) – 27%
   c. Polymer Tackifier – 3% ± 0.5%
   d. Moisture Content – 12% ± 3%

2. Seeded areas with slopes 8:1 or greater: Flexterra HP-FGM, by Profile Products:
   a. All components of the HP-FGM shall be pre-packaged by the Manufacturer to assure both material performance and compliance with the following values. Under no circumstances shall field mixing of components be permitted. No chemical additives with the exception of fertilizer, soil neutralizers and biostimulant materials should be added to this product.
   b. Thermally Processed* (within a pressurized vessel) Virgin Wood Fibers – 80%
   c. *Heated to a temperature greater than 380 degrees Fahrenheit (193 degrees Celsius) for 5 minutes at a pressure greater than 50 psi (345 kPa)
   d. Wetting agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents) – 10%
   e. Crimped Biodegradable Interlocking Fibers – 5%
   f. Micro-Pore Granules – 5%

2.02 TOPSOIL

A. All existing topsoil stripped for this work and suitable for reuse shall be stored on site as directed by the Landscape Architect. Dispose of all excess topsoil on the site as directed by the Landscape Architect.

B. Utilize on-site and imported topsoil to provide a minimum six inch (6”) layer of approved soil for hydromulch installation as specified and indicated on the Drawings.

C. If on-site topsoil is not available, imported topsoil shall be used as indicated on the drawings and as follows:
1. Imported Top Soil shall be natural, loose, fertile, friable, screened agricultural soil, having characteristics of representative productive soils in the vicinity, and

obtained from naturally well-drained areas. Imported Soil for seeded areas to be: "Enriched Top Soil", by Soil Building Systems, (972) 831-8181, or approved equal, submit a 1-quart package of existing and proposed topsoil with supplier label attached to sample.

2. Silt plus clay content of the import soil shall not exceed 20% by weight with a minimum 95% passing the 2.0 millimeter sieve. The sodium absorption ratio (SAR) shall not exceed 6 and the electrical conductivity (ECe) of the saturation extract of this soil shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade. The boron content shall be no greater than 1 part per million as measured on the saturation extract. In order to insure conformance, samples of the import soil shall be submitted to the laboratory for analysis prior to, and following, backfilling.
3. Imported Top Soil shall be free of insects, harmful nematodes, soil-borne diseases, toxins, heavy clay, select fill, inorganic subsoils, heavy metals, trash, petroleum by-products, rocks over 1" diameter, rubble, roots, weeds, or weed seeds.
4. Imported Topsoil shall have a pH between 6.5 - 7.3.
5. Proganics Biotic Soil Media – by Profile products

PART 3 - EXECUTION

3.01 INSPECTION

A. Obtain written certification from the General Contractor that final grades to within 0.10' have been established prior to commencing planting operations. Provide for inclusion of all amendments, settling, etc. The Contractor shall be responsible for shaping all planting areas as indicated on the drawings, or as directed by the Landscape Architect.

B. Inspect site to insure that it is ready to be seeded and that irrigation system is working for all areas to receive seed.

3.02 EXCAVATION

A. In all hydromulched and seeded areas, the Contractor shall *thoroughly* remove from the construction site all limestone larger than 3/4" in diameter and all heavy clay to a minimum depth of 6". The LA shall verify that this is complete before the Contractor is authorized to proceed with fill of specified topsoil or grading. Scarify subsoil after removal of rock or heavy clay before adding topsoil so as to break up any surface tension.

B. The Contractor shall thoroughly remove from the construction site all the following particles that are larger than 1/2" in diameter: inorganic select fill, heavy clay, limestone, and construction debris, mortar, concrete, paint, paint thinner, chemicals, weeds, plastic, paper, steel, wire, mortar, masonry, construction debris, and other substances that are harmful to plant growth. Remove the above items to these depths: 6" minimum in turf and seed areas, and 18" minimum in planting beds. The LA shall verify that the above items are removed before the Contractor is authorized to proceed with fill with specified topsoil or grading. DO NOT PLACE ANY FILL ON CONSTRUCTION DEBRIS.

C. After clean-up described above and establishment of subgrade, drag entire planting area with teeth of bucket to scarify subsoil to a depth of 4" to break up surface tension and allow water to pass downwards through the soil.

D. If soils are rocky or full of limestone or heavy clay, install irrigation system before adding topsoil so as to keep limestone or clay below imported topsoil and the root zone of plants.

E. Excavation for planting shall include the stripping and stockpiling of all acceptable topsoil encountered within the areas to be excavated for trenches, tree holes, plant pits, and planting beds.

F. Excess soil generated from the planting holes and not used as backfill or in the establishment of the final grades, shall be removed to an on-site location, as approved by the Owner. Unacceptable excess soil shall be removed to an appropriate off-site location.

G. Protect all areas from excessive compaction when trucking plants or other material to the planting site. Existing vegetation identified by the Landscape Architect to remain, shall be protected from trucking operations during the course of construction.

3.03 PRE-PLANT WEED CONTROL

A. After the irrigation system is operational and approved by the Landscape Architect, apply water for seven (7) to ten (10) calendar days, as needed to achieve weed germination.

B. If live perennial weeds exist on site at the beginning of the work, spray with a non-selective, systemic contact herbicide, as recommended and applied by an approved, licensed landscape pest control applicator. Leave sprayed plants intact for at least fourteen (14) days to allow systemic kill. Reapply at 2-week intervals until a complete kill is achieved.

C. Clear and remove these existing, dead weeds by mowing or grubbing off all plant parts at least 1" below the surface of the soil over the entire area to be planted.

D. Maintain the site weed-free until final acceptance by the Landscape Architect, utilizing mechanical and chemical treatment.

3.04 SOIL PREPARATION

A. Grade Preparation
1. Immediately before hydromulching, power-rake, scarify, loosen, float and drag the upper 6” of topsoil to bring it to the proper condition. Remove foreign matter larger than 1/2” in diameter. Hydromulch areas shall have topsoil that is light and fluffy after preparation.
2. If there is not sufficient existing approved topsoil on site, apply imported topsoil as specified in Section 2, MATERIALS, to achieve finish grade. If required, import specified and approved topsoil to achieve depth of (6”) depth in all seeded areas.
3. Amendments: Apply pH Soil Doctor granular Humate at a rate of 500 lbs. per acre directly into slurry.
4. Fine Grading: After tillage and cleaning, all areas to be planted shall be leveled, fine graded, and drug with a weighted spike harrow or float drag. The required result shall be the elimination of ruts or depressions that would cause water to stand or pond immediately after rainfall or operation of the lawn irrigation system, humps, and objectionable soil clods. This shall be the final soil preparation step to be completed before the commencement of fertilizing and planting.
5. If the prepared grade is eroded or compacted by rainfall prior to fertilizing, rework the surface to specified condition.

B. Spreading of Topsoil:
1. Topsoil and subgrade shall be damp when topsoil is spread. Top of subsoil shall be scarified and loose, not a hardpan before adding topsoil.

2. Areas to be seeded shall be top-soiled to a minimum depth of six inches (6”), compacted measure. Provide additional topsoil depths as required to construct the grades indicated on the Drawings. Topsoil shall be compacted to 85%, determined in accordance with ASTM: D 1557. Onsite topsoil is to be used unless it is not available, or is more than 25% clay, or is more than 10% limestone, or is rocky.

3.05 HYDROMULCHING

A. Hydromulch to be placed after final grade is approved in a timely manner not to exceed a 48-hour period from time of approval to hydromulching.

B. Apply Proganics Biotic Soil Media at a rate of 4,000 lbs per acre along with ½ of the seed mix. Then apply the other ½ of the seed mix as part of the hydromulch cap.

C. Apply seed via Hydromulch only (not via drill box or hand-spreading) during the periods indicated below unless otherwise approved by the Landscape Architect. Do not sow seed when weather conditions are unfavorable, such as during drought, rain, extreme cold or heat, or high winds. All seed shall be pre-treated at seed supplier with Root Inoculant (See Section 2.1C). Ship and plant seed immediately.

D. Hydromulching is much preferred over drill box or spreader. However, under certain circumstances, and if approved in writing by Landscape Architect, and if site is large enough and allows room for a tractor, the Landscape Architect may approve seeding using equipment such as cultipacker seeders (preferred), grass seed drill, or wildflower seeder. Seeds shall be evenly installed in multiple passes to a depth of ¼”- ½” under the surface of the soil at the rate specified on the plans.

E. Warm season turf grasses: Apply between April 15 and September 1, or when the ground temperature is above 65 degrees Fahrenheit.

F. Cool season turf grasses: Apply between September 1 and March 15, when temperatures are above 40 degrees Fahrenheit.

G. Native Grass Seed Mixes:
1. Without irrigation: Sow between March 1 and May 30.
2. With irrigation: Sow from March 1 to Sep 15 –(do not irrigate until after Apr. 1)

H. Native Wildflower Seed Mixes: Sow between September 15 and Nov 15.

I. If seeding cannot occur within the specified period; an alternative will be proposed by the Contractor for approval by Landscape Architect.

J. For seeded turfgrasses areas only - apply fertilizer (see section 2.1 F) with specified prescriptive agronomic formulations recommended in soil test. Hydromulch turf seed at a rate of 300 lbs. per acre over properly prepared surfaces. Confirm loading rates with equipment manufacturer.

K. Do not apply seed onto saturated soils or substrates.

L. Do not apply seed if rain is anticipated within 48 hours.

M. Prior to seeding, ensure that all soil shall be smooth, loose, and fluffy to a depth of 6”.

N. Hydromulching: All seeded areas are to be sprayed with a slurry using conventional Hydro-Mulch equipment as manufactured by the Bowie Machine Works, or an approved

equal. See Section 2.1, HYDROMULCHING for manufacturers of materials. The hydromulch slurry shall be thoroughly mixed with seed and applied at the rate of:

1. Seed: Variety and rate as called out on plans.
2. Hydromulch: 46 pounds per one thousand 1,000 SF (2,000 pounds per acre)
3. Water: 23 gallons per 1,000 square feet (1,000 gallons per acre).
4. Granular humate soil amendment: (10) lbs. per 1000 SF (435 pounds per acre)
5. Fertilizer: Apply 1200 lbs. per acre or 28 lbs. per 1000 sq. ft.

O. Strictly comply with equipment manufacturer's installation instructions and recommendations. Use approved hydro-spraying machines with fan-type nozzle (50-degree tip).

1. To achieve optimum soil surface coverage, apply Hydromulch from opposing directions downward to soil surface.
2. Use pressure of sprayer to force seed downward, 1/8” deep into soil.
3. Apply evenly to achieve 75% minimum cover.
4. Rough surfaces (rocky terrain, cat tracks and ripped soils) may require higher application rates to achieve specified cover.
5. Slope interruption devices or water diversion techniques are recommended when slope lengths exceed 25 feet (8 m). Maximum slope length is for product applications on a 4H:1V slope. For application on steeper slopes, slope interruption lengths may need to be decreased based on actual site conditions.
6. Do not install in channels or areas with concentrated water flow. No chemical additives with the exception of products listed above should be added to slurry.

P. Water thoroughly and immediately with a fine mist until soil is soaked to a depth of 3”. Maintain soil in a moist condition until seeds have sprouted and reached a height of 1”. Water thereafter at least once every 7 days unless natural rainfall has provided equivalent watering.

3.06 CLEAN-UP

A. After all planting operations have been completed, remove all trash, excess soil, empty plant containers, pallets, ties, rubbish, and all debris associated with this contract from the site. All scars, ruts, trench settlement, or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. The Contractor shall pick up all trash resulting from this work no less frequently than each Friday before leaving the site, once a week, or the last working day of each week. All trash shall be removed completely from the site.

B. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition. All walks shall be left in a clean and safe condition.

C. Excess topsoil not required for lawns or planting shall be stockpiled on site for future use as directed by the Owner's representative.

D. Repair existing lawns damaged by operations under the contract. Repair shall include finish grading, seeding as required to match existing grade and lawn, and maintenance of repaired areas.

3.07 OBSERVATION SCHEDULE

A. The Contractor shall be responsible for notifying the Landscape Architect in advance for the following site visits, according to the time indicated:

1. Pre-job Conference - 7 days
2. Final grade review - 2 days

3. Seed material review - 2 days
4. Soil Preparation and planting operations - 2 days
5. Pre-maintenance - 7 days
6. Final inspection - 7 days

B. When observations are conducted by someone other than the Landscape Architect, the Contractor shall show evidence, in writing, of when and by whom these observations were made.

C. NO site visits shall commence without all items noted in previous Observation Reports either completed or remedied unless such compliance has been waived by the Owner. Failure to accomplish punch list tasks or prepare adequately for desired inspections shall make the Contractor responsible for reimbursing the Landscape Architect at his current billing rates per hour, portal to portal (plus transportation costs) for the inconvenience. NO further inspections shall be scheduled until this charge has been paid and received.

3.08 GUARANTEE

A. All plant material shall be guaranteed by the contractor for a period of one (1) year from the date of final acceptance.

B. At the end of the guarantee period the Landscape Architect and Contractor shall inspect plant material. Any plant material under this contract that is dead or of an unsatisfactory growth condition shall be removed and replaced in a timely fashion by the contractor, at no cost to the owner.

3.09 ACCEPTANCE OF WORK

A. The contractor and Landscape Architect shall conduct an on-site inspection of all work and materials to determine compliance of work with the construction documents.

B. The contractor shall within reasonable means provide the Landscape Architect with sufficient data to demonstrate compliance with the construction documents.

C. The contractor shall be notified in writing of any non-conforming items, which are to be corrected (punch-list).

D. The contractor and Landscape Architect shall conduct an on-site inspection to verify completeness of punch list items.

E. Acceptance of work by the Owner shall begin upon verifying completion of punch list items and receipt of all deliverable items to Owner including letter of guarantee; release of liens waiver, record drawings denoting deviations from contract drawings, product data and maintenance guide.

F. The contractor shall receive written notification of date of final acceptance and ending date of required guarantee periods from the Landscape Architect.

3.10 90 DAY MAINTENANCE

A. The maintenance period shall commence when the Notice of Substantial Completion is issued and shall continue as required for a period of 90 days.

B. Immediately after hydromulching, the area shall be protected against traffic or other use by erecting barricades as needed, and by placing approved warning signs at appropriate intervals.

C. Contractor shall touch-up hydromulch areas as required to achieve full coverage at no cost to Owner.

D. Mow turf grasses only (not wildflower or native grass areas) during establishment only for the purpose of weed control and to promote quicker spreading.
1. Mow Bermuda and Zoysia Grass to a 2” height.
2. Mow at least once a week in the growing season once turf is rooted and growing.

E. Fill any depressions, settlement, or washouts that occurs within 90 days following installation. Reseed bare spots that occur during the maintenance period as directed by the Landscape Architect at no cost to Owner.

F. Keep lawns clean and protected from damage during the maintenance period. Debris that accumulates shall be removed from the site. Promptly repair damaged lawns except as pro-vided in Section 1.9, GUARANTEE AND REPLACEMENT.

G. Irrigate as required to supplement natural rainfall so that all lawn areas receive sufficient water for normal plant growth. Furnish all irrigation equipment needed for watering and be responsible for securing adequate supply of water if an automatic irrigation system does not exist, is not operating or is damaged.

H. A second fertilizer application shall be made 60 days after installation to turfgrasses. The specified fertilizer shall be a ratio of 15-5-10 applied at 800 pounds per acre.

END OF SECTION

SECTION 32 92 23

SOD

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

The requirements of the "General Conditions of the Contract" shall apply to all work of this Section with the same force and effect as though repeated in full herein.

1.02 SCOPE OF WORK

A. Furnish all labor, material, equipment, and services necessary to provide all landscape sodding, and sprigging work, complete in place, as shown on the drawings and as specified.

B. Work specified in this Section: The work includes, but is not necessarily limited to:
1. Soil preparation
2. Fine grading
3. Sodding (Solid rolled Sod)
4. Clean-up
5. Maintenance

C. Related work in other Sections:
1. 32 92 13 HYDROMULCHING
2. 32 93 00 TREES, SHRUBS, AND GROUNDCOVERS
3. 32 84 00 PLANTING IRRIGATION

D. Definition: The term of "Landscape Architect" shall refer to Teague Nall and Perkins, Inc., 5237 N. Riverside Drive, Suite 100, Fort Worth, Texas 76137.

E. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
1. American Society for Testing and Materials (ASTM): D 1557 Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 10 lb. (4.54 kg) Rammer and 18 in. (457mm) Drop.

1.03 SUBMITTALS

A. Samples and Product Information: Representative samples or product information of the following materials shall be provided to the Landscape Architect from the supply source that is to be used for turf areas:
1. Topsoil
2. Soil Amendments
3. Fertilizer: specifications and guaranteed analysis.
4. Biological Amendments: ingredients, chemical analysis, and manufacturer.
5. Sod certification documentation to include the following:
   a. Kind – Bermuda 419, Common Bermuda, St. Augustine, etc.
   b. Variety –Bermuda 419, etc.
   c. Lot Number – If applicable
   d. Record of square feet of sod shipped.
   e. Bill of Lading / Invoice # - This is an invoice number that can be referenced to the purchaser of the shipment.

f. Field # - the field number references the harvested grass to the production field. The field number must be the same as on the certification application and field inspection report.
g. Harvest Date – Record the date the grass was harvested.
h. Grower Name and Address- Record the production company name and address. Use of a stamp is acceptable if it shows on all copies.

B. Construction Schedule: At least two weeks prior to start of work, submit sodding schedule.

C. Maintenance: Submit three copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of the lawns for an entire year. Submit prior to Notice of Substantial Completion. See Section 3.10, 90 DAY MAINTENANCE

D. Chemicals: Submit products, rates of application, and anticipated uses of any pesticides, herbicides, and fumigants.

1.04 QUALITY ASSURANCE

A. Contractor's Qualifications
1. The work of this section shall be performed by a Contractor specializing in sodding or landscape installations.
2. The Contractor shall have successfully completed at least 5 installations of this type, size, and complexity in the last four years.

B. Lawn materials shall comply with all government regulations prevailing at the supply source and the job site.

C. Fertilizers; Mixed Commercial. Federal Specification: 0-F-241D

1.05 DELIVERY, STORAGE, AND HANDLING

A. Digging Sod
1. Do not dig sod at the nursery or other approved source until ready to transport sod to the project site or approved storage location.
2. Before stripping, sod shall be mowed at a uniform height of 2”.
3. Sod to be cut and delivered in rolled widths.
4. Cut sod to specified thickness and to standard width and length desired.

B. Transporting Sod
1. Sod transported to the Project in open vehicles shall be covered with tarps or other suitable covers securely fastened to the body of the vehicle to prevent injury to the sod. Closed vehicles shall be adequately ventilated to prevent overheating of the sod. Evidence of inadequate protection against drying out in transit shall be cause for rejection.
2. Sod shall be kept moist, fresh, and always protected. Such protection shall encompass the entire period during which the sod is in transit, being handled, or in temporary storage.
3. Transporting sod in excess of 20 miles from the site shall be done during evening, night, early morning hours during summer months
4. Upon arrival at the temporary storage location or the site of the work, sod shall be inspected for proper shipping procedures. Should the roots be dried out, the Landscape Architect will reject the sod. When sod has been rejected, the Contractor shall remove it at once from the area of the work and replace it at no cost to Owner.

5. Unless otherwise authorized by the Landscape Architect, the Contractor shall notify the Landscape Architect at least 48 hours in advance of the anticipated delivery date of sod. A legible copy of the invoice, showing species and variety of sod included for each shipment shall be submitted to the Landscape Architect.
6. Certificate of Inspection when required must accompany each sod shipment.

C. Handling and Storage of Sod
1. No sod shall remain in temporary storage over 30 hours, and less time may be required during extremely high temperatures.
2. Sod shall be kept moist and shall be stored in a compact group to prevent drying out or freezing.
3. Contractor shall take extreme care in the handling of sod material to avoid breaking or tearing strips. Sod that has been damaged by poor handling may be rejected by the Landscape Architect.

1.06 JOB CONDITIONS

A. Do not install sod on saturated, excessively dry, or frozen soil.

B. Sod installation shall be subject to suitability of the weather and other conditions affecting sod growth.

C. Planting season may be extended only with the written permission of the Landscape Architect.

1.07 SAMPLES AND TESTS

A. The Landscape Architect reserves the right to take and analyze samples of materials for conformity to specifications at any time. The Contractor shall furnish samples upon request by the Landscape Architect. Rejected materials shall be immediately removed from the site at the Contractor's expense. Cost of the testing of materials not meeting specifications shall be paid by the Contractor.

B. After rough grading is complete, Contractor shall order and pay for a soil test which includes recommendations. Take a minimum of one soil test per 10 acres - or more as site conditions mandate. Take approximately 15 cores from each uniform soil area. Mix them thoroughly in a clean plastic or paper container. Fill the soil sample bag one-third to one-half full from this representative sample. Acceptable labs are:
1. TPS Lab: “SO-05, TPSL® Plant Natural™ Soil Test + LOI Organic Matter + Solvita®”
2. A&L Plains Agricultural Laboratories: “Basic Test S2” and “Basic Test S3” and “Organic Matter – by Combustion” (all three tests are required)

C. Submit results to Landscape Architect for adjustment to soil amendments and fertilizers.

1.08 MAINTENANCE

A. All stored plant material shall be maintained in a healthy, vigorous condition by the Contractor. Maintenance includes, but is not necessarily limited to, mowing, weeding, edging, watering, trash removal, street and gutter cleaning, erosion repair, removal of siltation in drainage areas, and insect and disease chemical applications. The storage area shall be mowed, weeded, and trimmed weekly during the course of construction and the life of the storage area.

B. Within the limits of construction, the site shall be maintained in a neat, well-kept appearance by the Contractor. Maintenance includes, but is not necessarily limited to,

mowing, weeding, edging, watering, trash removal, street and gutter cleaning, erosion repair, removal of siltation in drainage areas, and insect and disease chemical applications.

C. Contractor shall maintain plant material as described in Part 3.6, 90-DAY MAINTENANCE

1.09 GUARANTEE AND REPLACEMENT

A. Warrant all lawns for a period of one year from date of Notice of Substantial Completion, to be at least the quality and conditions as at Final Acceptance. Promptly re-sod unacceptable areas during the warranty period as directed by the Landscape Architect.

B. Lawn shall be uniform in color, grass type, leaf texture, leaf and root density, and free from weeds, diseases, and other visible imperfections at acceptance.

C. Damage to the irrigation system by other trades or persons (such as shutting off of water or power to the irrigation system) shall not affect the warranty. This means that, especially in the warm season, the Contractor shall make daily visits to the site to inspect and repair the irrigation system up until final acceptance.

1.10 FINAL INSPECTION AND ACCEPTANCE

A. The Landscape Architect will inspect all work for Substantial Completion upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of inspection.

B. Acceptance will be based on establishment of a uniform stand of turf grass, defined as coverage of specified grass at a density of 95 percent coverage, with no bare spots greater than one square foot, free of weeds, undesirable grass species, disease, and insects. For grass varieties selected, allow a minimum of 90 days for establishment and maintenance of an acceptable strand of grass.

C. In areas that are grassed and not irrigated. An acceptable strand of grass shall be established and the Landscape Architect will inspect the work for Substantial Completion upon written request of the Contractor.

D. Upon completion and re-inspection of all repairs or renewals necessary in the judgment of the Landscape Architect, the Landscape Architect will recommend to the Owner that the work of this Section be accepted.

PART 2 - MATERIALS

2.01 SOLID SOD

A. Sod shall be as specified on plans, nursery grown on cultivated mineral agricultural soils. Sod shall have been mowed regularly and carefully and otherwise maintained from planting to harvest. Sod must be mowed two (2) days prior to cutting.

B. All sod shall be “Certified Sod” from a licensed and certified sod producer. Provide test results from a plant pathology lab to LA for approval before purchase.

C. For sports fields, or if called out on plans, use only rolled solid sod.

D. Thickness of Cut: Sod shall be cut to have minimum pad thickness of:
   1. Bermuda Grass: 3/4” minimum thickness, with plus/ minus 1/8” tolerance
   2. St. Augustine, Buffalo, and Zoysia Grass: 1” thick, with plus/ minus 1/8” tolerance

E. Width and Length of Sod: Maximum allowable deviation from standard widths and lengths shall be plus or minus 1/2” on width, and plus or minus 5% on length. Broken strips and torn or uneven ends will be rejected.

F. Strength of Sod Strips: Sod strips shall be strong enough to support their own weight and retain their size and shape if suspended vertically when grasped in the upper 10% of the section.

G. Moisture Content: Sod shall not be harvested or transplanted when moisture content (excessively wet or dry) may adversely affect its survival.

H. Sod shall consist of live growing plants secured from sources which have dense, thickly matted root system throughout the soil of the sod for a minimum of one inch. Sod shall be free of weeds or other varieties of grasses.

I. Reject any Sod whose roots are dried because of sun or wind. The landscape architect has the right to reject any or all of sod due to lack of care, improper cutting, or other agronomic problems.

J. Time Limitations: Sod shall be harvested, delivered, and transplanted within a 30-hour period unless a suitable preservation method is approved by the Landscape Architect prior to delivery. Sod not transplanted within this period shall be inspected and approved by the Landscape Architect prior to its installation.

K. Thatch: Sod shall be relatively free of thatch. A maximum on 1/2” (uncompressed) thatch will be permitted.

L. Sod shall be free of diseases, harmful insects, nematodes, soil borne diseases, Nutsedge, and all other grassy and broadleaf weeds.

M. Fertilizer for Sod areas: Italpollina 4-4-4 or approved equal. Product shall be an OMRI registered organic fertilizer of a guaranteed analysis, 4-4-4, containing no less than 41% total organic Carbon, 71% organic matter, and 5% humic acid. Contact: Allen Olson (817) 368-8615, allen@gdrsystems.net

2.02 TOPSOIL

A. All existing topsoil stripped for this work and suitable for reuse shall be stored on site as directed by the Landscape Architect. Dispose of all excess topsoil on the site as directed by the Landscape Architect.

B. Utilize on-site and imported topsoil to provide a minimum six-inch (6”) layer of approved soil for sod installation as specified and indicated on the Drawings.

C. If on-site topsoil is not available, imported topsoil shall be used as indicated on the drawings and as follows:
   1. Imported Top Soil shall be natural, loose, fertile, friable, screened agricultural soil, having characteristics of representative productive soils in the vicinity, and obtained from naturally well-drained areas. Imported Soil for sod areas to be: “Enriched Top Soil”, by Soil Building Systems, (972) 831-8181, or approved equal, submit a 1-quart package with supplier label attached to sample.

2. Silt plus clay content of the import soil shall not exceed 20% by weight with a minimum 95% passing the 2.0-millimeter sieve. The sodium absorption ratio (SAR) shall not exceed 6 and the electrical conductivity (ECe) of the saturation extract of this soil shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade. The boron content shall be no greater than 1 part per million as measured on the saturation extract. In order to ensure conformance, samples of the import soil shall be submitted to the laboratory for analysis prior to, and following, backfilling.
3. Imported Top Soil shall be free of insects, harmful nematodes, soil-borne diseases, toxins, heavy clay, select fill, inorganic subsoils, heavy metals, trash, petroleum by-products, rocks over 1” diameter, rubble, roots, Nutgrass, or weeds, or weed seeds.
4. Imported Topsoil shall have a pH between 6.5 - 7.3.

PART 3 - EXECUTION

3.01 INSPECTION

A. Obtain written certification from the General Contractor that final grades to within 0.10' have been established prior to commencing planting operations. Provide for inclusion of all amendments, settling, etc. The Contractor shall be responsible for shaping all planting areas as indicated on the drawings, or as directed by the Landscape Architect.

B. Inspect site to ensure that it is ready to be sodded and that irrigation system is working for all areas to receive sod.

3.02 EXCAVATION

A. In all sod areas, the Contractor shall *thoroughly* remove from the construction site all limestone larger than 1/2" in diameter and all heavy clay to a minimum depth of 6”. The LA shall verify that this is complete before the Contractor is authorized to proceed with fill of specified topsoil or grading. Scarify subsoil after removal of rock or heavy clay before adding topsoil so as to break up any surface tension.

B. The Contractor shall thoroughly remove from the construction site all the following particles that are larger than 1/2" in diameter: inorganic select fill, heavy clay, limestone, and construction debris, mortar, concrete, paint, paint thinner, chemicals, weeds, plastic, paper, steel, wire, mortar, masonry, construction debris, and other substances that are harmful to plant growth. Remove the above items to these depths: 6” minimum in turf and seed areas, and 18" minimum in planting beds. The LA shall verify that the above items are removed before the Contractor is authorized to proceed with fill with specified topsoil or grading. DO NOT PLACE ANY FILL ON CONSTRUCTION DEBRIS.

C. After clean-up described above and establishment of subgrade, drag entire planting area with teeth of bucket to scarify subsoil to a depth of 4” to break up surface tension and allow water to pass downwards through the soil.

D. If soils are rocky or full of limestone or heavy clay, install irrigation system before adding topsoil so as to keep limestone or clay below imported topsoil and the root zone of plants.

E. Excavation for planting shall include the stripping and stockpiling of all acceptable topsoil encountered within the areas to be excavated for trenches, tree holes, plant pits, and planting beds.

F. Excess soil generated from the planting holes and not used as backfill or in the establishment of the final grades, shall be removed to an on-site location, as approved by the Owner. Unacceptable excess soil shall be removed to an appropriate off-site location.

G. Protect all areas from excessive compaction when trucking plants or other material to the planting site. Existing vegetation identified by the Landscape Architect to remain, shall be protected from trucking operations during construction.

3.03 PRE-PLANT WEED CONTROL

A. After the irrigation system is operational and approved by the Landscape Architect, apply water for seven (7) to ten (10) calendar days, as needed to achieve weed germination.

B. If live perennial weeds exist on site at the beginning of the work, spray with a non-selective, systemic contact herbicide, as recommended and applied by an approved, licensed landscape pest control applicator. Leave sprayed plants intact for at least fourteen (14) days to allow systemic kill. Reapply at 2-week intervals until a complete kill is achieved.

C. Clear and remove these existing, dead weeds by mowing or grubbing off all plant parts at least 1" below the surface of the soil over the entire area to be planted.

D. Maintain the site weed-free until final acceptance by the Landscape Architect, utilizing mechanical and chemical treatment.

3.04 SOIL PREPARATION

A. Grade Preparation
1. Immediately before sodding, power-rake, scarify, loosen, float and drag the upper 6” of topsoil to bring it to the proper condition. Remove foreign matter larger than 1/2” in diameter. Sod areas shall have topsoil that is smooth and compacted to 85% after preparation.
2. If there is not sufficient existing approved topsoil on site, apply imported topsoil as specified in Section 2.1 G, MATERIALS, to achieve finish grade. If required, import topsoil to achieve depth of (6”) of approved topsoil in all turf areas.
3. Fine Grading: After tillage and cleaning, all areas to be planted shall be leveled, fine graded, and drug with a weighted spike harrow or float drag. The required result shall be the elimination of ruts or depressions that would cause water to stand or pond immediately after rainfall or operation of the lawn irrigation system, humps, and objectionable soil clods. This shall be the final soil preparation step to be completed before the commencement of fertilizing and planting.
4. If the prepared grade is eroded or compacted by rainfall prior to fertilizing, rework the surface to specified condition.
5. Sod to be placed after final grade is approved in a timely manner not to exceed a 48-hour period from time of approval to laying of sod.

B. Spreading of Topsoil:
1. Topsoil and subgrade shall be damp when topsoil is spread. Top of subsoil shall be scarified and loose, not a hardpan before adding topsoil.
2. Areas to be sodded shall be top-soiled to a minimum depth of six in. (6”), compacted measure. Provide additional topsoil depths as required to construct the grades indicated on the Drawings. Topsoil shall be compacted to 85%, determined in accordance with ASTM: D 1557. Onsite topsoil is to be used unless it is not available, or is more than 25% clay, or is more than 10% limestone, or is rocky.

C. Fertilizing for Sod Areas:
1. Till specified fertilizer (along with any amendment) into the top 1" of area to receive sod. Work fertilizer into the soil to a depth of ½"-1" after fine grading & not more than 2 days prior to grass planting. Cultivating equipment shall be set so the fertilizer will not penetrate the soil more than 1 inch. Do not apply fertilizer when there is a possibility of rain before lawn areas can be sodded.
2. Uniformly distribute granular Sod Fertilizer (See Section 2.2 M) by mechanical means at the rate of 1200 lbs. per acre or 28 lbs. per 1000 sq. ft.
3. Irrigate soil after fertilizer application and 1- 4 hours prior to laying sod.

3.05 SODDING

A. Weather Conditions
1. Schedule work for periods of favorable weather.
2. Do not place Sod on days that, in the judgment of the Landscape Architect, are too hot, sunny, dry, cold, wet, or windy for optimal growth.

B. Placement Pattern
1. The first row shall be laid in a straight line with subsequent rows parallel to the first row and tightly abutting each other.
2. Lateral joints shall be staggered. Care shall be exercised to ensure that the sod is neither stretched nor overlapped. Joints must be butted tightly to prevent voids that could permit air to dry out roots.
3. Immediately after placing, sod shall be pressed firmly into contact with sod bed by tamping or rolling to eliminate air pockets.
4. When on slopes steeper than 4 to 1, sod shall be secured by galvanized pins, wood pegs or other methods approved by the Landscape Architect.
5. Sand joints and top dress turf with topdressing sand as necessary to provide a smooth uniform finished surface.
6. Immediately after sodding operations have been completed, entire surface shall be compacted with a roller or other approved equipment. The completed area after sodding shall be uniformly even, firm, and true to finished grade lines.

C. Rolled Sod
1. For sports fields, or if called out on plans, use rolled solid sod.
2. Runs of rolled sod shall be maximized to minimize small pieces. Lay sod to avoid small or skinny pieces.
3. A bobcat and/or tractor with extra-wide tires and a "big roll" attachment shall be used to lay the rolls of sod.
4. Plastic netting shall be removed as sod is rolled out and properly disposed of upon installation as shown in the following photo:

D. Watering:
   1. Provide an adequate supply of water to keep the sod thriving at the site prior to and during transplanting of the sod.

3.06 CLEAN-UP

A. After all planting operations have been completed, remove all trash, excess soil, empty plant containers, pallets, ties, rubbish, and all debris associated with this contract from the site. All scars, ruts, trench settlement, or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. The Contractor shall pick up all trash resulting from this work no less frequently than each Friday before leaving the site, once a week, or the last working day of each week. All trash shall be removed completely from the site.

B. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition. All walks shall be left in a clean and safe condition.

C. Excess topsoil not required for lawns or planting shall be stockpiled on site for future use as directed by the Owner's representative.

D. Repair existing lawns damaged by operations under the contract. Repair shall include finish grading and sodding as required to match existing grade and lawn, and maintenance of repaired areas.

3.07 OBSERVATION SCHEDULE

A. The Contractor shall be responsible for notifying the Landscape Architect in advance for the following site visits, according to the time indicated:
   1. Pre-job Conference - 7 days
   2. Final grade review - 2 days
   3. Sod material review - 2 days
   4. Soil Preparation and planting operations - 2 days
   5. Pre-maintenance - 7 days
   6. Final inspection - 7 days

B. When observations are conducted by someone other than the Landscape Architect, the Contractor shall show evidence, in writing, of when and by whom these observations were made.

C. NO site visits shall commence without all items noted in previous Observation Reports either completed or remedied unless such compliance has been waived by the Owner. Failure to accomplish punch list tasks or prepare adequately for desired inspections shall make the Contractor responsible for reimbursing the Landscape Architect at his current billing rates per hour, portal to portal (plus transportation costs) for the inconvenience. NO further inspections shall be scheduled until this charge has been paid and received.

3.08 GUARANTEE

A. All plant material shall be guaranteed by the contractor for a period of one (1) year from the date of final acceptance.

B. At the end of the guarantee period the Landscape Architect and Contractor shall inspect plant material. Any plant material under this contract that is dead or of an unsatisfactory growth condition shall be removed and replaced in a timely fashion by the contractor, at no cost to the owner.

3.09 ACCEPTANCE OF WORK

A. The contractor and Landscape Architect shall conduct an on-site inspection of all work and materials to determine compliance of work with the construction documents.

B. The contractor shall, within reasonable means, provide the Landscape Architect with sufficient data to demonstrate compliance with the construction documents.

C. The contractor shall be notified in writing of any non-conforming items, which are to be corrected (punch-list).

D. The contractor and Landscape Architect shall conduct an on-site inspection to verify completeness of punch list items.

E. Acceptance of work by the Owner shall begin upon verifying completion of punch list items and receipt of all deliverable items to Owner including letter of guarantee; release of liens waiver, record drawings denoting deviations from contract drawings, product data and maintenance guide.

F. The contractor shall receive written notification of date of final acceptance and ending date of required guarantee periods from the Landscape Architect.

3.10 90 DAY MAINTENANCE

A. The maintenance period shall commence when the Notice of Substantial Completion is issued and shall continue as required for a period of 90 days.

B. Immediately after sodding, the area shall be protected against traffic or other use by erecting barricades as needed, and by placing approved warning signs at appropriate intervals.

C. Contractor shall touch-up sod areas as required to achieve 100% coverage at no cost to Owner.

D. Mow turf grasses only (not wildflower or native grass areas) during establishment only for the purpose of weed control and to promote quicker spreading.
   1. Mow Bermuda and Zoysia Grass to a 2” height.
   2. Mow St Augustine Grass to a 4” height.
   3. Mow at least once a week in the growing season once turf is rooted and growing.

E. Fill any depressions, settlement, or washouts that occurs within 90 days following installation. Re-sod bare spots that occur during the maintenance period as directed by the Landscape Architect at no cost to Owner.

F. Keep lawns clean and protected from damage during the maintenance period. Debris that accumulates shall be removed from the site. Promptly repair damaged lawns except as pro-vided in Section 1.9, GUARANTEE AND REPLACEMENT.

G. Irrigate as required to supplement natural rainfall so that all lawn areas receive sufficient water for normal plant growth. Furnish all irrigation equipment needed for watering and be responsible for securing adequate supply of water if an automatic irrigation system does not exist, is not operating or is damaged.

H. A second fertilizer application shall be made 60 days after installation to turfgrasses. The specified fertilizer (see section 2.1.L) shall be applied at 800 pounds per acre or 18 lbs. per 1,000 SF.

END OF SECTION

SECTION 32 93 00

TREES, SHRUBS, AND GROUNDCOVERS

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

The requirements of the "General Conditions of the Contract" shall apply to all work of this Section with the same force and effect as though repeated in full herein.

1.02 SCOPE OF WORK

A. Furnish all labor, material, equipment, and services necessary to provide all landscape planting, complete in place, as shown on the drawings and as specified.

B. Work specified in this Section: The work includes, but is not necessarily limited to:
1. Soil preparation
2. Fine grading
3. Metal edging
4. Planting
5. Staking and Guying
6. Clean-up
7. Maintenance

C. Related work in other Sections:
1. 32 92 13 HYDROMULCHING
2. 32 92 23 SOD
3. 32 84 00 PLANTING IRRIGATION

D. Definition: The term "Landscape Architect" or “LA” shall refer to Teague Nall and Perkins, Inc. 5237 N. Riverside Drive, Suite 100, Fort Worth, Texas 76137.

1.03 SUBMITTALS

A. Samples and Product Information: Representative samples or product information of the following materials shall be provided to the Landscape Architect from the supply source that is to be used for Trees, Shrubs, and Groundcover areas: Plant type and nursery with clear pictures showing a measuring rod and person for scale.

B. Samples and product information: one-quart size sample in a quart-size baggie, list of ingredients, guaranteed chemical analysis, and manufacturer for:
1. Topsoil
2. Soil Amendments and Compost
3. Fertilizer
4. Weed Barrier for DG (cut-sheet only)
5. Decomposed Granite
6. Mulch
7. Trip/ Delivery tickets on all above items to verify delivery date, source, type, and quantity

C. Construction Schedule: At least two weeks prior to start of work, submit planting schedule.

D. Maintenance: Submit three copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of the landscape for an entire year. Submit prior to Notice of Substantial Completion.

E. Chemicals: Submit products, rates of application, and anticipated uses of any pesticides, herbicides, and fumigants.

1.04 QUALITY ASSURANCE

A. Qualifications
1. The Contractor shall be a company specializing in landscape installation.
2. The Contractor shall have successfully completed at least 5 installations of this type, size, and complexity in the last four years.

B. All materials and work shall comply with applicable sections of the following references:
1. American Association of Nurserymen, Inc., (AAN) Standard: American Standard for Nursery Stock (ANSI Z60.1, Most recent addition).
2. ANSI A 300 – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts.
3. Florida Grades and Standards for Nursery Stock, current edition (Florida Department of Agriculture, Tallahassee FL).
4. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
   a. USDA - The Germplasm Resources Information Network (GRIN) http://www.ars-grin.gov/npgs/searchgrin.html
   b. Manual of Woody Landscape Plants; Michael Dirr; Stipes Publishing, Champaign, Illinois; Most Current Edition.
5. Pruning practices shall conform to recommendations “Structural Pruning: A Guide For The Green Industry” most current edition; published by Urban Tree Foundation, Visalia, California.
6. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign IL, most current edition.
7. Fertilizers; Mixed Commercial. Federal Specification: 0-F-241D

C. Source Quality Control:
1. Submit documentation to the Landscape Architect within ten (10) calendar days after award of the Contract that all plant material is available. The Contractor shall be responsible for all material listed on the plant list. Any substitutions due to unavailability must be requested, in writing, prior to confirmation of ordering. All material shall be subject to inspection by the Landscape Architect at any time after confirmation of ordering.
2. Plants shall be subject to inspection and approval of the Landscape Architect at the place of growth, or upon delivery for conformity to the specifications. Such approval shall not impair the right of inspection and/ or rejection during the progress of the work. Inspection and tagging of plant material by the Landscape Architect is for design intent only and does not constitute the Landscape Architect's approval of the plant materials in regard to their health and vigor as specified in Part 2, Section 2.1, H., Plant Material.
3. The health and vigor of the plant material is the sole responsibility of the Contractor. Submit written request for inspection of plant material at the place of growth to the Landscape Architect. Written requests shall state the place of

growth and quantity of plants to be inspected. The Landscape Architect reserves the right to refuse inspection at this time if, in his judgment, a sufficient quantity of plants is not available for inspection.

4. The Contractor shall submit specifications of any item being used on site, upon the request of the Landscape Architect.
5. The Contractor shall obtain and pay for all permits required by local codes.
6. Ordinances and Regulations: All local, municipal, and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and make a part of these specifications, and their provisions shall be carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations, or requirements of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery:
1. Deliver fertilizer to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade mark, and conformance to State law.
2. The Contractor shall furnish the Landscape Architect with copies of receipts for all amendments specified in Section 2.1, Materials, or amended by the Soils Report specified in Section 3.2, Preparation.
3. Deliver all plants with legible identification labels.
   a. Label trees, bundles of containers of like shrubs, or groundcover plants.
   b. State the correct botanical plant name and size indicated on the plant list, on the drawings.
   c. Use durable waterproof labels with water-resistant ink which will remain legible for at least 60 calendar days.
4. Protect plant material during delivery to prevent damage to the root ball or desiccation of leaves.
5. Tarp trees and plant material with canvas, or similar material, during delivery of any length, on any open-air transport.
6. Transporting trees in excess of 20 miles from the site shall be done during evening, night, early morning hours during summer months. The Contractor shall routinely stop the transport and water root balls at pre-determined intervals. Intervals shall be in agreement with the Landscape Architect, as determined in advance of the transport.
7. The Contractor shall notify the Landscape Architect seven (7) calendar days in advance of delivery of all plant materials and shall submit an itemized list of the plants in each delivery.

B. Storage:
1. An on-site location shall be made available for plant material storage. Security and protection of the storage area shall be the Contractor's responsibility.
2. Store plant material in shade and protect from weather.
3. Maintain and protect plant material not to be planted within four (4) hours in a healthy, vigorous condition.
4. Storage of plant materials shall be neat, orderly, and grouped according to like plants.
5. Plant material, upon delivery, shall be inspected for transport damage, disease, and insect infestation. Any infected material shall be immediately removed from

site at Contractor's expense. Notify Landscape Architect in writing upon discovery of any pests.

6. The Contractor shall be responsible for completely restoring the storage area to the original condition prior to final acceptance of construction. Restoration shall occur within seven (7) calendar days of written notification by the Landscape Architect.

C. Handling: The Contractor is cautioned to exercise care in handling, loading, unloading, and storing of plant materials. Plant materials that have been damaged in any way will be discarded, and if installed, shall be replaced with undamaged materials at the Contractor's expense.

1.06 JOB CONDITIONS

A. Perform actual planting only when weather and soil conditions are suitable in accordance with locally accepted practice.

B. Scheduling: Install trees, shrubs, and groundcover before hydraulic seeding or sodding operations are commenced.

1.07 SAMPLES AND TESTS

A. The Landscape Architect reserves the right to take and analyze samples of materials for conformity to specifications at any time. The Contractor shall furnish samples upon request by the Landscape Architect. Rejected materials shall be immediately removed from the site at the Contractor's expense. Cost of the testing of materials not meeting specifications shall be paid by the Contractor.

B. After rough grading is complete, Contractor shall order and pay for a soil test which includes recommendations. Take a minimum of one soil test per 10 acres - or more as site conditions mandate. Take approximately 15 cores from each uniform soil area. Mix them thoroughly in a clean plastic or paper container. Fill the soil sample bag one-third to one-half full from this representative sample. Acceptable labs are:

1. TPS Lab: "SO-05, TPSL® Plant Natural™ Soil Test + LOI Organic Matter + Solvita®"
2. A&L Plains Agricultural Laboratories: "Basic Test S2" and "Basic Test S3" and "Organic Matter – by Combustion" (all three tests are required)

C. Submit results to Landscape Architect for adjustment to soil amendments and fertilizers.

1.08 MAINTENANCE

A. All stored plant material shall be maintained in a healthy, vigorous condition by the Contractor. Maintenance includes, but is not necessarily limited to, mowing, weeding, edging, watering, trash removal, street and gutter cleaning, erosion repair, removal of siltation in drainage areas, and insect and disease chemical applications. The storage area shall be mowed, weeded, and trimmed weekly during construction and the life of the storage area.

B. Within the limits of construction, the site shall be maintained in a neat, well-kept appearance by the Contractor. Maintenance includes, but is not necessarily limited to, mowing, weeding, edging, watering, trash removal, street and gutter cleaning, erosion repair, removal of siltation in drainage areas, and insect and disease chemical applications.

C. Contractor shall maintain plant material as per section 3.7, 90 DAY MAINTENANCE.

1.09 GUARANTEE AND REPLACEMENT

A. All materials (living and non-living) and workmanship shall be guaranteed for a period of one year after the Date of Acceptance by the Owner. When the work is accepted in parts, the guarantee periods shall extend from each of the partial acceptances to the terminal date of the last guarantee period. Thus, all guarantee periods terminate at one time.

B. Plants shall be healthy, free of pests and disease, and in flourishing condition at the end of the guarantee period. Plants shall be free of dead and dying branches and branch tips, and shall bear foliage of normal density, size, and color.

C. Contractor shall promptly replace all dead plants and all plants not in a vigorous, thriving condition, as determined by the Landscape Architect during and at the end of the guarantee period, without cost to the Owner, as soon as weather conditions permit and within the specified planting period. Replacements shall match adjacent specimens of the same species. Replacements shall be subject to all the requirements stated in this Specification. Contractor to make all necessary repairs due to plant replacements. Such repairs shall be done at no cost to the Owner.

D. The guarantee of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. If a replacement plant is not acceptable during or at the end of the said extended guarantee period, the Owner may elect one more replacement or credit for each item.

E. Damage to the irrigation system by other trades or persons (such as shutting off of water or power to the irrigation system) shall not affect the warranty. This means that, especially in the warm season, the Contractor shall make daily visits to the site to inspect and repair the irrigation system up until final acceptance.

F. Scheduling of replacements within a reasonable time shall be as determined by the Owner. In the event of failure to make such repairs or replacements within a reasonable time after receipt of written notice from the Owner, the Contractor authorizes the Owner to proceed to have said repairs or replacements made at Contractor’s expense and Contractor agrees to reimburse Owner within 60 days.

1.10 FINAL INSPECTION AND ACCEPTANCE

A. At the end of the guarantee period, the Landscape Architect will, upon written notice of end of guarantee period inspect the work for Final Acceptance. Request shall be received at least ten calendar days before the anticipated date for Final Inspection.

B. Upon completion and reinspection of full repairs or replacements necessary in the judgment of the Landscape Architect at that time, the Landscape Architect will recommend to the Owner that Final Acceptance of the Work of the Section be given.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The following specified soil amendments and fertilizer are to be used for bid prices basis only. Specific amendments and fertilizer specification will be made after rough grading operations are complete and soil samples are tested by the Laboratory at the

Contractor's expense. See "Table of Soil Amendments, Fertilizer, and Mulch" on drawings for a summary.

B. All materials shall be of standard, approved, and first-grade quality and shall be in prime condition when installed and accepted. Any commercially processed or packaged material shall be delivered to the site in the original, unopened container bearing the manufacturer's guaranteed analysis. The Contractor shall supply the Landscape Architect with a sample of all supplied materials accompanied by analytical compliance or bearing the manufacturer's guaranteed analysis.

C. Soil Amendment for shrub and groundcover beds and stand-alone tree planting: "Gumbo Buster", by Soil Building Systems, 972-831-8181, or approved equal. See Submittals Section 1.3 B.

D. Fertilizer for Tree, Shrub, and Groundcover Areas: Italpollina 4-4-4 or approved equal. Product shall be an OMRI registered organic fertilizer of a guaranteed analysis, 4-4-4, containing no less than 41% total organic Carbon, 71% organic matter, and 5% humic acid. Contact: Allen Olson (817) 368-8615, allen@gdrsystems.net.

E. Imported Topsoil shall:

1. Be loose, fertile, friable, screened horticultural soil, having characteristics of representative productive soils in the vicinity, and obtained from naturally well-drained areas. Imported Topsoil for planting beds to be: "Ready-to-Plant", by Soil Building Systems, (972) 831-8181, or approved equal. See Section 1.3 B.
2. Include fully composted cotton burrs, local grass, leaves, brush and processed wood fiber and shall add an average of 1.44 lbs. of N, 0.22 lbs. P, and 0.9 lbs. K of pure consumable organic nutrients per 100 square feet for each inch depth added plus minerals and trace elements. Compost shall not include food waste, stable waste, treated lumber, pallets, pine bark, raw manure or mushroom compost waste. Compost shall not include any man-made materials or chemicals. Do not use mixed municipal solid waste compost. Ensure compost does not contain any visible inorganic refuse, other physical contaminants, or any substance considered harmful to plant growth. It must be turned at least 5 times and not exceed a temperature of 160 degrees Fahrenheit. Each turning cycle should not be shorter than 14 days minimum. Supporting compost process documentation should be made available by compost vendor upon request.
3. Be comprised of pH Balanced Compost, select screened soil, and screened non-washed sand.
4. Have 98.5% of media passing through a ½ screen and 99%+ passing through a ¾ inch screen. The Imported Topsoil will weigh between 1,900 and 2,250 lbs. per cubic yard.
5. Not contain, or be created from, treated lumber, pallets, construction waste, pine bark, straw, raw mulch, raw manure, livestock stable bedding litter/waste, food waste, or mushroom compost waste.
6. Be free of insects, harmful nematodes, soil-borne diseases, toxins, heavy clay, select fill, inorganic subsoils, heavy metals, trash, petroleum by-products, rocks over 1" diameter, rubble, roots, weeds, weed seeds, Clopyralid, or Picloram.
7. Have a pH between 6.0 and 7.0.
8. Silt plus clay content of the import soil shall not exceed 20% by weight with a minimum 95% passing the 2.0-millimeter sieve. The sodium absorption ratio (SAR) shall not exceed 6 and the electrical conductivity (ECe) of the saturation extract of this soil shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade. The boron content shall be no greater than 1 part per million as measured on the saturation extract. In order to ensure conformance, samples of

the import soil shall be submitted to the laboratory for analysis prior to, and following, backfilling.

F. Plant Material:

1. Name and Variety: Provide plant materials true to name and variety described in Quality Assurance Section 1.4 B.
2. Plants shall be in accordance with the Texas State Department of Agriculture's Regulation for nursery inspections, rules, and ratings.
3. All plant material shall be No. 1 grade nursery stock or better, grown in accordance with good horticultural practice. Plants shall be free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions, or disfigurement. They shall be sound, healthy and vigorous, of uniform growth, typical of the species and variety, well formed, free from irregularities, with the minimum quality conforming to American Standard for Nursery Stock.
4. Plants indicated as specimen shall be exceptionally heavy, symmetrical, and tightly knit, cultured, to be unquestionably superior in form, branching, compactness, and symmetry.
5. The minimum acceptable sizes of all plants shall be measured before pruning and with branches in normal position. Unless otherwise designated on the plant list, all plant dimensions shall conform to those listed in ANSI Z60.1, American Standard for Nursery Stock.
6. Branching point is the distance above ground where balanced branching occurs or where a dimension in trunk appears to form the head of the tree.
7. Trees shall not have included bark in the crotches of the limbs. Trees with included bark shall be rejected.
8. Root Treatment: Root treatments on all plants shall conform to the requirements of ANSI Z60.1. Plants shall be dug and prepared for shipment in a manner that will not cause damage to branches, shape, and future development after planting.
9. Plants furnished in containers shall have the roots well established in the soil mass and shall have growth in the container for at least one growing season. Containers shall be large enough to provide earth root mass of adequate size to support the plant tops being grown.
10. Container-grown trees shall have a root ball measuring 10" of diameter for each 1" of tree caliper. The tree caliper shall be measured on the trunk, 12" above the finish grade or root flare of the tree. Plants, other than ground covers, over established in the container, as evidenced by pot bound root ends, will not be accepted.
11. B&B and Collected Plant Material (only permitted if specifically called out on plans) shall have a root ball measuring 12" of diameter for each 1" of tree caliper. The tree caliper shall be measured on the trunk, 12" above the finish grade or root flare of the tree.
12. If plants are specified as balled and burlapped (B&B), then B&B plants shall have a firm, natural ball of earth of sufficient diameter and depth to encompass the fibrous and feeding root systems necessary for full recovery of the plant. Balls shall be securely wrapped with burlap and bound with cord or a wire basket. Ball sizes shall meet the requirements of the ANSI Z60.1, or as indicated on the Drawings. B&B trees shall have been hardened off, meaning that they shall have been dug 6-52 weeks prior to shipment.
13. Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, and larvae. At the time of planting all plants shall have a root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant.

14. Plant materials are subject to final approval by the Landscape Architect at the job site.
15. All plants not conforming to the requirements herein specified, shall be considered defective and such plants, whether in place or not, shall be marked as rejected and immediately removed from the site of the work and replaced with new plants at the Contractor's expense. The plants shall be of the species, variety, size, and conditions specified herein or as shown on the drawings. Under no conditions will there be any substitutions of plants or sizes listed on the accompanying plans, except with the expressed, written consent of the Landscape Architect.

G. Plant Root Quality
1. Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Acceptance details and the following:
   a. The roots shall be reasonably free of scrapes, broken or split wood.
   b. The root system shall be reasonably free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high quality root system are not considered injuries.
2. A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species. Plants with structural roots on only one side of the trunk (J roots) shall be rejected.
3. The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.
4. The root system shall be reasonably free of stem girdling roots over the root collar or kinked roots from nursery production practices.
5. At time of observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

H. Staking Materials:
1. Tree support stakes shall be Tree Frog Pro Series above ground guying system or approved equal. (352) 735-7411. Install according to manufacturer’s instructions.
2. Size according to:
   a. Pro 20 – up to 2” caliper trees
   b. Pro 40 – up to 4” caliper trees
   c. Pro 60 – up to 6” caliper trees
3. Straps to be 3/4” wide, woven, green polypropylene, 900 lb. break strength, UV resistant strapping, provided by manufacturer.
4. Anchors to be arrowhead-shaped aluminum alloy (HD).

I. Tree Paint (for Oaks only to prevent spread of Oak Wilt): Tanglefoot Tree Wound Pruning Sealer (emulsified asphalt) or approved equal.

J. Weed Barrier: Do not use weed barrier in planting beds. Weed Barrier product for DG or gravel or stone areas shall be “Weed Barrier Pro” as supplied by DeWitt Company 1-800-888-9669 or approved equal.

K. Water: Source furnished by the Contractor, cost and transport of water, as required, by the Contractor.

L. Mulch: “Fine Cut Hardwood Mulch” by Soil Building Systems, or approved equal - submit sample.

M. Drainage Sand: course, clean, sharp, washed river sand, with no debris.

N. Metal Edging: Shall be Permaloc 3/16-inch thick x 4-inch high, extruded aluminum, 6063 alloy, T-6 hardness, landscape edging for straight-line and curvilinear applications in corrugated straight profile, as manufactured by Permaloc Corporation, Holland MI 49424, telephone (800) 356-9660 or approved equal. Each section shall have loops on its side to receive stakes spaced approximately 2 to 3 feet apart along its length. Steel edging is not acceptable.
1. For straight runs: Permastrip “L” shape, (Ref #: 006-045)
2. For curved runs: Cleanline, (Ref #: 006-0165)
3. Finish: Black Duraflex
4. Stakes: 12” long, color matched to edging
5. Length: 16’-20’ long interlocking pieces

PART 3 - EXECUTION

3.01 INSPECTION

A. Obtain written certification from the General Contractor that final grades to within 0.10' have been established prior to commencing planting operations. Provide for inclusion of all amendments, settling, etc. The Contractor shall be responsible for shaping all planting areas as indicated on the drawings, or as directed by the Landscape Architect.

B. Inspect trees, shrubs, and groundcover plant material for injury, insect infestation, and trees and shrubs for improper pruning.

C. Do not begin planting of plants until deficiencies are corrected.

3.02 EXCAVATION

A. In all planting beds, the Contractor shall *thoroughly* remove from the construction site all limestone larger than 3/4" in diameter and all heavy clay to a minimum depth of 18”. Use a power rake to remove rocks from sites with more than 1 rock per SY. The LA shall verify that this is complete before the Contractor is authorized to proceed with fill of specified topsoil or grading. Scarify subsoil after removal of rock or heavy clay before adding topsoil to break up any surface tension.

B. The Contractor shall thoroughly remove from the construction site all the following particles that are larger than 3/4" in diameter: inorganic select fill, heavy clay, limestone, and construction debris, mortar, concrete, paint, paint thinner, chemicals, weeds, plastic, paper, steel, wire, mortar, masonry, construction debris, and other substances that are harmful to plant growth. Remove the above items to these depths: 6” minimum in turf and seed areas, and 18" minimum in planting beds. The LA shall verify that the above

items are removed before the Contractor is authorized to proceed with fill with specified topsoil or grading. DO NOT PLACE ANY FILL ON CONSTRUCTION DEBRIS.

C. After clean-up described above and establishment of subgrade, drag entire planting area with teeth of bucket to scarify subsoil to a depth of 4” to break up surface tension and allow water to pass downwards through the soil.

D. Excavate planting beds so that the rough grade is 8”-9” below top of adjacent pavement or curbs to allow for addition of compost, planting soil, and mulch.

E. If soils are rocky or full of limestone or heavy clay, install irrigation system before adding topsoil to keep limestone or clay below imported topsoil and the root zone of plants.

F. Excavation for planting shall include the stripping and stockpiling of all acceptable topsoil encountered within the areas to be excavated for trenches, tree holes, plant pits, and planting beds.

G. Excess soil generated from the planting holes and not used as backfill or in the establishment of the final grades, shall be removed to an on-site location, as approved by the Owner. Unacceptable excess soil shall be removed to an appropriate off-site location.

H. Protect all areas from excessive compaction when trucking plants or other material to the planting site. Existing vegetation identified by the Landscape Architect to remain, shall be protected from trucking operations during construction.

3.03 PRE-PLANT WEED CONTROL

A. After the irrigation system is operational and approved by the Landscape Architect, apply water for seven (7) to ten (10) calendar days, as needed to achieve weed germination.

B. If live perennial weeds exist on site at the beginning of the work, spray with a non-selective, systemic contact herbicide, as recommended and applied by an approved, licensed landscape pest control applicator. Leave sprayed plants intact for at least fourteen (14) days to allow systemic kill. Re-apply at 2-week intervals until a complete kill is achieved.

C. Clear and remove these existing, dead weeds by mowing or grubbing off all plant parts at least 1" below the surface of the soil over the entire area to be planted.

D. Maintain the site weed-free until final acceptance by the Landscape Architect, utilizing mechanical and chemical treatment.

3.04 SOIL PREPARATION

A. Topsoil: If there is not enough existing approved topsoil on site, apply imported topsoil as specified in Section 2.01 G, MATERIALS, to achieve finish grade. If required import topsoil to achieve depth of 24” of approved topsoil in planting beds and tree pits.

B. Amendments: After finished grades have been established, soil shall be conditioned in the following manner:
   1. For stand-alone tree pits: (1) part soil amendment to (2) parts native or imported topsoil.
   2. For planting beds:

a. After rough grade is established, thoroughly till 2” of Gumbo Buster 2” into existing soil until there is a 4” soil layer that is evenly mixed, loose, and friable.
b. Add a full 6” of “Ready-to-Plant” soil mix on top of soil mix.

C. Fertilization:
1. Trees: Fertilize tree pits at time of planting. Apply specified fertilizer (see Section 2.1.E) into tree pits at the rate of 1/4 cup per caliper inch to backfill around the root ball. Apply the fertilizer in the presence of the landscape architect. Failure to apply the fertilizer in the presence of the Landscape Architect will result in the Contractor's responsibility to apply a second fertilization, at a time determined by the Landscape Architect, at no additional cost to the Owner. See Section 2.01 E, MATERIALS.
2. Shrubs, groundcover, and seasonal color areas: Till fertilizer into the top 6” of the planting bed at the rate of 20 lbs. per 1000 SF. Irrigate immediately following the application. See Section 2.01 E, MATERIALS

D. Fine Grading: Contractor shall fine grade all areas for approval by LA. Contractor shall be responsible for providing 2% positive drainage in all planting areas. No planting or mulching will take place until all construction, clean-up, fine grading, and irrigation is complete in the immediate area. Final finish grading shall be reviewed by the LA before any planting takes place. Contractor shall be responsible for any additional topsoil required to create a smooth condition prior to planting.

E. All planting areas shall drain away from buildings by at least 2%.

3.05 PLANT INSTALLATION

A. General:
1. Actual planting shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted practice, as approved by the Landscape Architect. Do not plant when raining or into waterlogged or frozen soil.
2. Only as many plants as can be planted, staked, and watered on that same day shall be distributed in a planting area.
3. Containers shall be opened and plants shall be removed in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered as herein specified immediately after removal from the containers. Containers shall not be opened prior to placing the plants in the planting area.

B. Lay-Out of Trees: Locations for Trees and bedlines shall be marked on the ground by the Contractor before any tree pits are dug. All such locations shall be approved by the Landscape Architect.
1. If underground construction or utility lines are encountered in the excavation of planting areas, other locations for planting may be selected by the Landscape Architect. It shall by the Contractor's responsibility to confirm with the Owner, Landscape Architect, and all governing agencies, the location and depth of all underground utilities and obstructions.
2. Lay-out shall be accomplished with flagged grade stakes indicating tree names and specified plant size on each stake.

C. Container Removal: Cut the container on the sides with an acceptable can cutter. Do not injure the root ball. After removing the plant from the container, superficially cut the edges of roots with a sharp knife in three (3) equally spaced locations.

D. Ball & Burlap Removal: Cut off the top 6" of the wire basket. All wire on the root ball with less than a 4" x 4" grid pattern shall be removed entirely and disposed of at an off-site location. Remove all burlap, rope, twine, and wire from around the plant trunk. Lay any burlap back approximately 12", exposing a minimum of the top one-third (1/3) of the root ball. All material or fabric used as a substitution for burlap and is not equal to the degradable qualities of burlap, shall be removed entirely from the root ball and disposed of at an off-site location.

E. Box Container Removal: Remove the bottom of the plant boxes before planting. Place the plant in the pit, position, and backfill to a minimum of one-third the depth of the root ball. Remove the sides of the boxes without damaging the root ball.

F. Planting of Trees and Shrubs:
1. Planting pits shall be round and sized in accordance with outlines and dimensions shown on the drawings.
2. All excavated tree holes shall have sloped sides (see detail) with roughened surfaces and shall be of a size that is two (2x) times the diameter of the root ball for all trees. The depths of all excavated holes shall have a roughened pit bottom and shall be of a depth equal to the depth of the root ball or roots for all trees and shrubs.
3. If rotating augers or other mechanical diggers are Used to excavate holes, the vertical sides of the pits shall be scarified, fractured, or otherwise broken down to eliminate impervious surfaces.
4. Loosen or scarify the bottom of all plant pits to a depth of 4 inches.
5. SCARIFY ALL ROOTBALLS (#1 and larger) to prevent plants from remaining pot-bound. This is to be done by hand or with a 3-prong cultivator but never with a shovel or machete.
6. Center the plant in the pit or trench.
7. Place shrubs and groundcovers so that the top of the rootball is ¼" to ¾" above finish grade. Trees shall be set 1" above finish grade for each caliper inch of trunk. Example: A 3" tree shall be set 3" above finish grade. DO NOT, UNDER ANY CIRCUMSTANCE, PLANT TREES, SHRUBS OR GROUNDCOVER BELOW FINISH GRADE. DO NOT PLACE ANY SOIL ON TOP OF ROOTBALLS.
8. Set the plant plumb and hold rigidly in position until the soil has been tamped firmly around the root ball or roots.
9. After the plant has been placed, backfill shall be added to the hole to cover approximately one-half (1/2) the height of the root ball. At this stage, water shall be added to the top of the partly filled hole to thoroughly saturate the root ball and adjacent soil. WATER IN AND COMPACT PLANTING BACKFILL TO PREVENT FORMATION OF AIR POCKETS.
10. Backfill the remainder of the hole after the water has percolated and is not standing in the hole. Construct a three-inch (3") water saucer around the edge of the hole. The planting shall be immediately irrigated after planting until the entire area is saturated to the full depth of each hole.

G. Staking and Guying:
1. Each tree shall be staked into undisturbed soil immediately following planting. Plants shall stand plumb after staking. See detail for staking guidelines. All

stakes and guys shall be installed taught, equally spaced, and beyond the root ball. Refer to the detail on drawings.

H. Pruning:

1. Pruning shall be limited to the minimum necessary to remove injured twigs and branches. All limbs growing in a conflicting, crossing fashion with one another shall be pruned. Pruning may NOT be done prior to the delivery and acceptance of the plant material. PRUNING SHALL BE DONE ONLY IN THE PRESENCE OF THE LANDSCAPE ARCHITECT.
2. Do not use pruning paint except for Oak Trees. For Oaks, follow best practices by TexasOakWilt.org
   a. Clean all pruning tools with 10% bleach solution or Lysol between sites and/or trees.
   b. If possible, avoid pruning Oaks from Feb 1 - June 30.

I. Planting of Groundcovers and Seasonal Color:

1. Plants shall be grown in pots as indicated on the drawings. Plants shall remain in those pots until the time of transplanting into the designated areas. The pot's soil shall contain enough moisture so that it will not fall apart when lifting the plants from the pot.
2. Groundcover and seasonal color shall be planted in straight rows, evenly spaced, and at spacing called out on the drawings, unless otherwise noted on the drawings. Triangular spacing shall be used unless otherwise noted on the drawings.
3. Each rooted plant shall be planted with its proportionate amount of soil. Planting shall be immediately irrigated after planting until the entire area is saturated to the full depth of each hole.
4. Care shall always be exercised to protect the plants after installation. Any damage to the plants by trampling or other operations of this Contract shall be repaired immediately.
5. Seasonal color material and placement will be selected by the Landscape Architect at the time of installation.
6. The Owner and Landscape Architect reserves the right to review and approve all plant material at the nursery or grower.

J. Mulch Cover:

1. All trees, shrubs, groundcover, and seasonal color areas shall be top-dressed with a (4) four-inch (3” inches after settlement) minimum layer of mulch within 48 hours after planting. Install no more than 1.5” of mulch over the top of the root balls of all plants. See Section 2.01 M.

3.06 CLEAN-UP

A. After all planting operations have been completed, remove all trash, excess soil, empty plant containers, rubbish, and all debris associated with this Contract from the site. All scars, ruts, trench settlement, or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. The Contractor shall pick up all trash resulting from this work no less frequently than each Friday before leaving the site, once a week, or the last working day of each week. All trash shall be removed completely from the site.

B. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition. All walks shall be left in a clean and safe condition.

3.07 OBSERVATION SCHEDULE

A. The Contractor shall be responsible for notifying the Landscape Architect in advance for the following site visits, according to the time indicated:
   1. Pre-job Conference - 7 days
   2. Final grade review - 2 days
   3. Plant material review - 2 days
   4. Plant lay-out review - 2 days
   5. Soil Preparation and planting operations - 2 days
   6. Pre-maintenance - 7 days
   7. Final inspection - 7 days

B. When observations are conducted by someone other than the Landscape Architect, the Contractor shall show evidence, in writing, of when and by whom these observations were made.

C. NO site visits shall commence without all items noted in previous Observation Reports either completed or remedied unless such compliance has been waived by the Owner. Failure to accomplish punch list tasks or prepare adequately for desired inspections shall make the Contractor responsible for reimbursing the Landscape Architect at his current billing rates per hour, portal to portal (plus transportation costs) for the inconvenience. NO further inspections shall be scheduled until this charge has been paid and received.

3.08 90 DAY MAINTENANCE

A. The maintenance period shall commence when the Notice of Substantial Completion is issued and shall continue as required for a period of 90 days.

B. Plants shall be inspected at least once per week by the Contractor during the installation period and needed maintenance performed promptly.

C. The Contractor shall irrigate all plants adequately to maintain optimum supply of moisture within the root zone; recurring overly dry or wet conditions shall be grounds for rejection of plant material. If the irrigation system is inoperative, hand watering shall be accomplished from a source approved by the Landscape Architect. Water shall not be applied with a force that will displace mulch or cause soil erosion and shall not be applied so quickly that it cannot be absorbed by the mulch and plants.

D. Plants shall be pruned, and mulch shall be replaced as required.

E. Tree stakes and guys shall be adjusted or replaced as required. Repair eroded plant saucers.

F. Always maintain all plant beds and tree saucers weed-free.

G. Keep plants free of insects and disease. All insecticides and fungicides applied to control pests and maintain plants in a healthy growing condition shall be approved by the Landscape Architect.

H. Fertilize plants at once during the warranty period. Fertilization shall be applied by topdressing 2 pounds per 100 square feet of bed area, and 3 to 5 pounds each tree. Fertilizer for the application shall be a controlled release type used for the installation.

I. Remove and replace, at no cost to Owner, dead and unacceptable plants as their condition becomes apparent.

END OF SECTION

SECTION 33 09 30

PUMP CONTROL SYSTEM FOR DUPLEX SEWAGE PUMP STATION

PART 1. GENERAL

1.1. SCOPE

A. The work in this section shall include furnishing and placing into operation the monitoring and control panel of a pump station with **2** submersible wastewater pumps.

B. The controller shall alternate the pumps and operate the pumps always at its best efficiency

1.2. RELATED SECTIONS

A. SECTION 33 32 13.13 PREFABRICATED SEWAGE PUMP STATION WITH 2 SUBMERSIBLE PUMPS

1.3. REFERENCES

A. Electrical work shall be in accordance with Division 16 - Electrical
B. UL 508A and 698A
C. NFPA 70 - NEC (2017)
D. NFPA 820
E. ISA 5.1 and 5.4

1.4. SUBMITTALS

A. Submittals shall include but not be limited to the following:

1. Shop drawings
2. Bill of Material (BOM)
3. Wiring diagrams
4. Outline and dimension drawings
5. Enclosure mounting details

1.5. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle products to site under provisions of NCTCOG Item 106 “Control of Material” and manufacturer’s recommendations.
B. Store in a clean, dry space.
C. Lift only with lugs provided for the purpose.
D. Handle carefully to avoid damage to internal components, enclosure and finish.

1.6. QUALIFICATION REQUIREMENTS

A. The manufacturer shall provide data on alternate equipment manufacturer's experience. Only Manufacturers with 20 or more years of experience who have furnished at least 20 similar lift stations that have been in regular operation not less than 5 years will be considered. Evidence of experience and operational data may be required from the manufacturer to determine the suitability and efficiency of the equipment offered.

B. The Manufacturer shall be able to offer Alarm Transmission Service via CLOUD (Internet) for a monthly fee. Information such as SMS or email shall be available 24 hours / 7 days with and update interval: 60 seconds

1.7. INSTALLATION

A. After installation, a pump station start-up shall be performed by the installing contractor under the supervision of the manufacture’s authorized representative. **F**ield service shall be provided by an authorized, factory trained representative of the pump manufacturer. Services shall include, but not be limited to, inspection of the completed pump station installation to

ensure that it has been performed in accordance with the manufacturer's instructions and recommendations, supervision of all field-testing and activation of the Pump Manufacturer's Warranty. The test shall demonstrate to the satisfaction of the Owner that the equipment meets all specified performance criteria, is properly installed and anchored, and operates smoothly without exceeding the full load amperage rating of the motor. The Contractor shall be responsible for coordinating the required field services with the Pump Manufacturer.

B. All electrical work performed shall be in full accordance to the requirements of the Division 16 (Electrical) Specifications.

1.8. WARRANTY

A. When installed in accordance with all the provisions of this section, related sections and the supplier's installation manual, the warranty on the Monitoring and Control equipment shall be 60 months.

B. The warranty period shall start from the date of equipment delivery to the job site.

PART 2. PRODUCTS / MONITORING & CONTROL

2.1. MONITORING & CONTROL / PUMP DRIVE (FLYGT SMARTRUN SRC 300 OR EQUIVALENT)

A. The station is equipped with **2** pumps. Each pump shall be equipped with a pump drive unit sized to match the submersible electric motor and designed for a power supply from 230-480V 60 Hz 3 phase.

B. The pump drive shall provide all level control functionality, hand/auto operation, pump alternation, pump over temperature monitoring, seal leakage monitoring, pump self-cleaning, and pipe cleaning algorithms. The pump drive shall also include capability to monitor station inflow, pump speed and energy consumption in order to automatically operate the pump station at optimal energy efficiency.

C. One Pump drive per pump should be used to allow full redundancy and alternation.

D. It shall be tested and approved in accordance with international standards , the European safety directive 98/37/EC, the Low Volt-age Directive 2006/95/EC, the EMC Directive 2004/108/EC and in accordance with the European standards: EN 61800-5-1:2003; EN 61800-3; EN 55011:2007; EN60529 and EN 60204-1

E. The software shall be programmed with all parameters and settings pre-configured for an efficient operation.

F. It shall be freestanding for wall mounting or cabinet installation construction and equipped with an air ventilated system.

G. Without any limitation or derating, it shall operate in ambient temperature of up to 40°C (104°F) at an altitude up to 1000m.

H. It shall include provision for external communication to higher-level system. Communication shall be via 2-wire RS-485 connection to the pump drive. Communication shall be available as MODBUS RTU.

I. Serial communication capabilities shall include, but not be limited to set Start- and stop level, Pump clean interval, speed and ramp times as well as PID control parameters.

J. The communication telegram shall include process variable feed-back like Sump level, power (kW), Output speed/frequency, current (A), % torque, relay outputs, digital inputs and drive status and fault information.

K. Following function shall be provided by the equipment:

1. High/Low Level Sump Control:

   a. The pump drive shall provide automatic level control via means of a submersible pressure transducer (4-20mADC). User-programmable Start Level shall indicate the point at which the pump will start. Upon activation the pump shall run at maximum speed for a pre-determined period, then ramp down to the energy efficient Optimal speed, calculated by the pump drive. When the water level reaches the Stop Level, the pump shall stop. The Optimal Speed shall either be calculated by the pump drive or manually entered by the user.

   b. In case of high inflow, the pump drive shall increase pump speed until the water level begins to decrease. When the water level reaches the Stop Level, the pump shall stop.

   c. In case of very high inflow, in a duplex installation, when a single pump is unable to overcome the inflow conditions even at maxi-mum speed, additional pumps shall be activated and run at maxi-mum speed until the Stop Level is reached. If water levels continue to rise, a High Level Alarm shall be activated.

   d. The pump drive shall incorporate a Minimum Speed function that prevents the pump from operating at speeds too low to move water based on the pump curve.

2. Run Time Averaging and random start levels

   a. The pump drive shall provide capability to balance run times for even wear. This shall be an internal function of the drive and not require external devices, such as an alternating relay.

   b. Each drive shall determine its own random start level independent of each other. New random start levels shall be determined after each pump cycle. The pump with the lowest random start level shall be first to start on any given pump cycle. The second pump shall remain in Standby capacity in case the lead pump shall not be able to lower the water level as described in the section above. By recalculating the random start levels every pump cycle the operating hours of the pumps shall be balanced and the settling of “Grease-rings” in the station shall be avoided.

3. Pump Cleaning Function:

   a. The Pump drive shall incorporate a “self-cleaning” function to remove debris from the impeller. The cleaning shall be triggered by following circumstances:

      - Soft Clogging: When motor current is increasing over a certain period of time defined by the pump supplier.
      - Hard Clogging: When motor current is increase drastically and pump stops.

   b. The cleaning function shall consist of forced stopping, reversal and forward runs timed to allow for debris to fall from the impeller. After cleaning cycle is complete, drive shall resume to automatic operation.

4. Sump Cleaning Function:

   a. The pump drive shall incorporate a sump cleaning function to ensure surface solids and grease is regularly removed from the sump. The sump cleaning function shall perform regularly when enabled by the operator. Sump cleaning shall consist of the following functions:

      - Sump cleaning is triggered when internal timer expires and during a normal pump down cycle
      - Pump is automatically ramped to maximum speed
      - Pump runs at maximum speed for designated time or until the pump are

snoring."
- When Sump Cleaning is over, the pump is shut off and resumes normal operation.

5. Pipe Cleaning Function:
   a. The pump drive shall incorporate a pipe cleaning function to avoid discharge pipe sedimentation and clogging due to reduced pump speed. This shall be an automatic feature that initiates with every pump cycle. Upon reaching Pump Start Level, the drive shall operate the pump at 100% speed for a determined time before ramping down to the most energy efficient speed for the duration of the cycle.

6. Energy efficient speed finder:
   a. The pump drive shall provide a function that automatically calculates the most energy efficient speed for the pump based on station inflow characteristics. The speed shall be constantly adjusted to account for changes of the inflow without requiring operator adjustment.
   b. This function shall also prevent the drive from running off of the system curve and ensure the maximum hydraulic efficiency.

7. Alarms & Monitoring:
   a. The pump drive shall provide alarms and monitoring for the drive, pump and sump. Alarms shall be presented on the LCD display, via a Summary Alarm relay and via Modbus registers. All alarms, when occurring, shall remain active until reset.

   Alarms shall have a built-in 4 second delay to prevent nuisance tripping.

   Alarms shall be as follows:

   1. Motor monitoring:
      a. Motor Temperature too high
      b. Leakage in stator housing
   2. Sump monitoring:
      a. High sump Level (via float switch or transducer)
      b. transducer sensor error (connection failure, faulty values)
   3. Pump drive monitoring:
      a. overcurrent or overload trip
      b. over- or under voltage
      c. ambient or drive temperature too high
      d. ambient temperature too low.
      e. input phase loss
      f. max torque exceeded

L. USER UÍNTERFACE

1. The pump drive shall incorporate an (OLED) LCD screen to dis-play drive operating status, alarms, liquid level and parameters.
2. The pump drive shall include 7 pushbuttons with the following functions: Pump Start, Pump Stop, Hand (Manual) Operation, Auto Operation, Menu Access, Increase Value, and Decrease Value.
3. Pump Start Level, Operating Parameter Adjustment and Alarm History shall be accessed via menu structure. Menu shall have at least 2 levels of security, limiting access to qualified personnel only.

4. The LCD screen shall display status information in 4 modes: Off, standby, active auto and active Manual.

5. The information shown shall be as follows:

OFF:	Firmware name, Status (“STOP”), Rating (kW/hp)
STANDBY:	Status and Name, Operating Mode, Sump Level
Auto/Manual:	Status and Name, Operating Mode, Motor Freq. Power, Sump Level, Current

2.2. LEVEL CONTROL (FLYGT ENM 10)

A. Each station shall be equipped with 2 Float switches for backup level sump control approved according LVD EN61058.

B. CSA approved according Class I Zone 0, Gr. IIC and Div.1 Gr A, B, C&D

C. Material of casing: Polypropylene.

D. Degree of protection: NEMA 6.

E. They shall be applicable for liquids with a density of 0.95 – 1.10 g/cm3. The Level control shall include 40 feet submersible cable.

2.3. LEVEL TRANSMITTER (FLYGT LTU 801)

A. Each station shall be equipped 1 Level transmitter approved acc. EN 61000-6-2, EN 61000-6-3, EN 61326-1**.** It shall be approved for explosive areas according UL Class 1, 2 and 3 Division 1 Group A-D T4/T5/T6

B. Output 4–20 mA direct current, proportional to the measured level. Low supply voltage 8–30 V DC – or battery operation.

C. It shall be suitable for wastewater with a diaphragm made of ceramic.

D. Insulated > 100 MΩ at 500 V DC. Material of sensor body: Ryton PPS.

E. Degree of protection: Nema 6.

F. The transmitter shall include 50 feet submersible cable.

2.4. CABINET

A. The Monitoring & Control and the telemetry and 2 pump drives shall be assembled in a cabinet. It shall be made of Reinforced plastic or stainless steel and it shall be prepared for an installation on a concrete floor.

B. Beside the Monitoring & Control unit it shall have enough space for the customer-installed telemetry equipment and include.

- 1 backup battery for the telemetry unit.
- Red-dome style flashing alarm light
- Alarm Horn or Bell with Alarm silence button
- Intrinsically safe barrier for UL 913 requirements
- Anti-condensation heater and thermostat
- Generator receptacle and Emergency circuit breaker (walking-beam interlocked with Main breaker)
- Enclosure legs
- Power switch, which can be locked in the off position by a pad-lock.
- 1 light group with socket

C. The inner dimension of the cabinet shall reserve at least 10% back panel space for future adjustments.

D. All components on the front of the machine should be provided with function plate.

PART 3. EXECUTION

3.1. GENERAL

A. Perform installation in accordance with Contract Documents and manufacturers specifications.

3.2. EXAMINATION

A. A factory trained technician shall examine the work area prior to beginning work and check the following:

1. The environment is safe to begin working in
2. All surfaces are ready to receive work
3. All tools are in the proper location and are in good condition
4. Grounding of the system

3.3. FIELD QUALITY CONTROL

A. The follow field tests shall be performed by a factory trained technician

1. Point to point wiring verification
2. Utility power verification
3. Site acceptance testing
4. System demonstration

B. Point to Point I/O Verification

1. After installation of the pumps and the control panel, a factory trained technician shall prepare the I/O checklist. The checklist shall include the following:
    a. All inputs and outputs connected to the control panel
    b. All alarms that can be generated by the control panel
2. The technician shall follow a test procedure to test all I/O and alarms.
    a. All digital inputs shall be tested from point of origin unless it is unsafe.
    b. All digital outputs shall be tested by running a simulation test from the controller or by simulating the fault condition.
    c. All analog inputs shall be tested from the point of origin where possible and by use of a signal generator otherwise.
    d. All analog outputs shall be tested by running a simulation program or by forcing the output to a value.
3. The technician shall follow a test procedure to ensure the system operation parameters are met.

C. Configuration Verification

1. The factory trained technician shall document the settings using a factory provided configuration checklist. Each parameter shall be verified prior to the beginning of testing and then again after testing is completed.
2. The configuration of the pump station manager as well as the IPS gateways shall be documented.
3. The pump station manager configuration shall be saved to a factory provided SD card after testing is completed.

3.4. FACTORY TRAINED SUPERVISION

A. The contractor shall procure a factory trained technician to check over equipment prior to putting the equipment into operation.

B. Point to point test of all wiring

C. Functional test of all equipment alarms and controls.

3.5. CERTIFICATION OF TESTING

A. All tests shall be performed in the presence of a duly authorized representative of the Owner. If the presence is waived, certified results shall be provided by the Contractor.

B. Written notice of all tests shall be given two weeks in advance.

3.6. TEST EQUIPMENT

A. All test equipment shall be provided by the Contractor.

3.7. TRAINING

A. Training shall be a minimum of four (4) hours and cover the complete Pumping System and related controls.

B. Instruction material shall be provided for four (4) trainees.

SECTION 33 10 00

WATER UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established in the North Central Texas Council of Government (NCTCOG) Standard Specifications for Public Works Construction, City Specifications, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Work Included:
1. Installation of pipe material, fittings and concrete blocking.
2. Construction of fire hydrants, water meters, service lines, gate valves and detector checks.
3. Construction of improvements to City service stub.
4. Coordination with City work forces for extension of water improvements to serve this site.

B. Related Work Specified in Other Sections
1. Section 31 23 33 - Trenching and Backfilling
2. Section 31 00 00 - Earthwork

1.03 COORDINATION

A. Contractor shall coordinate installation of water system with other construction throughout the site.

B. All construction shall conform to NCTCOG and applicable City Standard Specifications for Construction.

C. All work of this Section shall be completed within the limits of the site property boundary or public right-of-way.

1.04 REFERENCES

A. AWWA C900: Requirements for PVC pressure pipe 4" thru 8" pipe
B. AWWA C110 or C907: Ductile Iron Fittings.
C. AWWA C502: Fire Hydrant Installation.
D. AWWA C500: Gate Valves
E. Texas Commission on Environmental Quality (TCEQ), Title 30 Texas Administrative Code (TAC), Chapter 290, “Public Drinking Water”.
Rule §290.38 Definitions
Rule §290.39 General Provisions
Rule §290.44 Water Distribution
Rule §317.13 Appendix E – Separation Distances
F. NSF International NSF/ANSI 61 Drinking Water System Components – Health Effects
G. National Fire Protection Association (NFPA) NFPA 24 Installation of Private Fire Service Mains and Their Appurtenances

1.05 SUBMITTALS

A. Submit manufacturer’s product data sheets to Engineer for review. All pipe, fittings and appurtenances not covered by this specification shall be approved by the engineer 7 days prior to bid.

B. Test Reports: Provide two (2) copies of each field quality control tests including, but not limited to hydrostatic tests, bacteriological tests, infiltration/exfiltration tests, mandrel tests, video camera test, flow test, etc.

C. Contractor is to accurately record installation of piping systems with appurtenances and present the information to Owner at the completion of the project as “Project Record Drawings”.

PART 2 - PRODUCTS

2.01 PIPE

A. Polyvinyl Chloride (PVC) water pipe and fittings with dimension control.

1. PVC Water Pipe, 4” through 12”: AWWA C900, Class 150, DR-18.
2. PVC Fireline Pipe, 4” through 12”: AWWA C900, Class 200, DR-14.

2.02 FIRE HYDRANTS

A. Manufacture and style per City specifications and applicable sections of NCTCOG Item 502.3.

2.03 GATE VALVES

A. Manufacturer, type per City specifications and applicable sections of NCTCOG Item 502.6.

2.04 WATER METERS, DETECTOR CHECK

A. Manufacturer, type per City specifications and applicable sections of NCTCOG Item 502.10.

2.05 METER BOXES, VAULTS

A. Precast/cast-in-place per City specifications, plan details and applicable sections of NCTCOG Item 502.10.

PART 3 - EXECUTION

3.01 GENERAL

A. The locations of all structures and lines and grades of all pipes shall be staked by a registered surveyor. All facilities shall be located according to the site layout plans.

3.02 PIPES

A. All pipe shall be inspected prior to installation. Damaged pipes shall not be used. Replacement of damaged pipe shall be made by the Contractor at no expense to the owner.

B. Pipe installation shall conform to the North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction.

END OF SECTION

SECTION 33 30 00

SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established in the North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction, City of Fort Worth and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Work Included:
   1. Installation of pipe material.
   2. Construction of manholes.
   3. Connection to existing sewer system.

B. Related Work Specified on Other Sections
   1. Section 31 23 33 - Trenching and Backfilling
   2. Section 33 00 00 - Earthwork

1.03 COORDINATION

A. Verify flowline elevation at connection to existing manhole; notify architect if elevation is more than 0.1’ above plan elevation.

B. Coordinate installation with other construction throughout the site.

C. All construction shall conform to NCTCOG and applicable City Standard Specifications for Construction.

1.04 REFERENCES

A. ASTM D3034: Specifications for PVC Sewer Pipe 4” through 15” in diameter.

B. ASTM D2321: Practice for Installation of Underground Installation

1.05 SUBMITTALS

A. All pipe and fittings not covered by this specification shall be approved by the engineer seven days prior to bid.

PART 2 - PRODUCTS

2.01 PIPE

A. Polyvinyl Chloride (PVC) sewer pipe and fittings with dimension control.

   1. Pipe shall be SDR-26.
   2. Pipe Fittings: Pipe fittings shall conform to ASTM D1784. Fittings approved by the Engineer shall also be acceptable.
   3. Balance of specifications shall be covered by applicable City specifications and NCTCOG Item 501.17.

2.02 Structures

A. Materials for the construction of manholes shall be as specified in Division 700, “Concrete Structures” of the NCTCOG’s Standard Specifications for Construction.

PART 3 - EXECUTION

3.01 GENERAL

A. The locations of all structures and lines and grades of all pipes shall be staked by a registered surveyor. All facilities shall be located according to the site layout plans.

B. Contractor shall utilize necessary measures including temporary pumping and collection until the public sewer improvements are installed and operational.

3.02 PIPES

A. All pipes shall be inspected prior to installation. Damaged pipes shall not be used. Replacement of damaged pipe shall be made by the Contractor at no expense to the owner.

B. Installation shall be in accordance with NCTCOG and City specifications and as recommended by the pipe manufacturer. Backfill shall be per plans.

3.03 STRUCTURES

A. Construction of manholes shall be as specified in Division 700, “Concrete Structures” of NCTCOG and the City’s Standard Specifications for Construction.

B. Connections of pipe to structures shall be completely mortared around the perimeter of the pipe to ensure connection to the structure prior to backfilling. Pipe shall have a rubber boat placed over the end prior to pouring concrete structure or grouting.

C. All manholes in pavement areas shall be held below pavement and the frame/lid shall be adjusted to final grade with grade rings. There should be no abrupt grade changes at manholes rims. **If abrupt grade changes are present, grade adjustments will be required.**

END OF SECTION

SECTION 33 32 13.13

PREFABRICATED SEWAGE PUMP STATION WITH 2 SUBMERSIBLE PUMPS

PART 1. GENERAL

1.1. SCOPE OF WORK

A. The work in this section shall include furnishing and placing into operation one prefabricated sewage pump station(s) complete with 2 submersible pumps, internal piping, lifting chains, guide rails, valve vault and access covers as specified herein and as indicated on the drawings. The complete pump station shall be submersible up to 65 feet above the inlet pipe level.

1.2. RELATED SECTIONS

A. Section 33 09 30 PUMP CONTROL SYSTEM FOR DUPLEX SEWAGE PUMP STATION

1.3. REFERENCES

A. American Society for testing and material (ASTM) International
1. A 48: Standard Specification for Gray Iron Castings.
2. A743: Standard Specification Iron-Chromium Nickel, Corrosion Resistant,

B: American National Standards Institute (ANSI):
1. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.

C. Hydraulic Institute: Current Standards.
1. HI 14.6: Hydrodynamic Pumps for Hydraulic Performance Acceptance Tests.
2. HI 11.6: Submersible Pump Tests

1.4. SUBMITTALS

A. Submittal data shall be provided to show compliance with these specifications, plans or other specifications that will influence the proper operation of the pump(s).

B. Standard submittal data for approval must consist of:

1. Pump Performance Curves.
2. Pump Outline Drawing.
3. Station Drawing for Accessories.
4. Electrical Motor Data.
5. Typical Installation Guides.
6. Technical Manuals and Parts List.
8. Printed Warranty.
9. Management system certificate ISO 9001.
10. Manufacturer's Equipment Storage Recommendations.
11. Manufacturer's Standard Recommended Start-Up Report Form.

C. Lack of the above requested submittal data is cause for rejection.

1.5. QUALIFICATION REQUIREMENTS

A. The manufacturer shall provide data on alternate equipment manufacturer's experience. Only Manufacturers with 20 or more years of experience who have furnished at least 5 similar lift stations shall be considered.

B. After installation, a pump station start-up shall be performed by the installing contractor under the supervision of the manufacture's authorized representative. 8 hours of field service shall be provided by an authorized, factory trained representative of the pump manufacturer. Services shall include, but not be limited to, inspection of the completed pump station installation to ensure that it has been performed in accordance with the manufacturer's instructions and recommendations, supervision of all field-testing and activation of the Pump Manufacturer's Warranty. The test shall demonstrate to the satisfaction of the Owner that the equipment meets all specified performance criteria, is properly installed and anchored, and operates smoothly without exceeding the full load amperage rating of the motor. The Contractor shall be responsible for coordinating the required field services with the Pump Manufacturer.

1.6. DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle products to site under provisions of NCTCOG Item 106 "Control of Material" and manufacturer's recommendations.

1.7. OPERATIONAL REQUIREMENTS AND WARRANTY

A. The contractor shall supply and install **one** prefabricated and preassembled sewage pump station(s).

B. Each sewage pump station shall be completely issued with discharge connections, discharge pipes, guide bars, safety grit and cable holder to assemble 2 submersible waste water pumps.

C. For each pump station the contractor shall supply and install a separate valve vault.

D. The contractor shall supply and install 2 submersible sewage pumps

E. The submersible pumps shall have a semi open multi vane self-cleaning impeller designed to transport wastewater with fibrous materials like wet wipes.

F. The impeller shall be wear resistant and made of high chromium cast iron with at least 24% chrome against sand and grit which is expected to enter the pump station with the sewage or the storm water. Impellers that have surface hardening (by thermal, coating, etc.) will not be allowed.

G. Each pump shall be capable to lift 270 **USgpm** at a total dynamic head of 48 **feet**.

H. The pumps shall be provided with 60 months (5 years) warranty against defects in materials and or workmanship. The warranty shall cover the entire pump, not individual components. Upon warranty occurrence, the manufacturer's authorized service center shall remove the pump, repair, reinstall and provide start up on the repaired pump. A detailed failure analysis shall be submitted to the Owner for their records summarizing corrective action taken.

I. The manufacturer shall guarantee clog-free operation for a period of 24 months from the date of start-up of the pumps by the local authorized factory representative. A certificate shall be provided to the Owner on the day of start up with the local contact information and effective date. Should the impeller clog with typical solids and/or modern trash debris normally found in domestic wastewater during this period, an authorized representative shall, either travel to the jobsite, remove the pump, clear the obstruction and reinstall the pump at no cost or reimburse the Owner for reasonable cost to provide this service. A written report shall be provided to the Owner detailing the service call with pictures for verification purposes.

PART 2. PRODUCTS

2.1. PREFABRICATED SEWAGE PUMP STATION (FLYGT TOP 6 OR EQUIVALENT)

A. The sewage pump station shall be made of Fiberglass reinforced polymer (FRP) equipped with discharge connections, discharge pipes, valves, guide bars and cable holder to assemble 2 submersible waste water pumps. The material of the complete station shall be applicable for waste water with a PH value from 5.5 to 8.0. The Inner diameter shall be 72**"**.

B. All dimensions incl. inlet and outlet positions shall be made according to plan details.

C. The station cylinder shall be affixed to the station bottom such that the assembled components are structurally integrated, resulting in a watertight vessel which is capable of withstanding the full hydrostatic head from the exterior of the station while the station is completely empty.

D. The cylinder shall be made of FRP using the filament winding process. A safety factor of two (2) on the minimum ultimate tensile strength of the laminate bottom shall be used in designing the basin and cylinder wall thicknesses for the station, taking into account all normally imposed loads arising from flotation, soil pressures, normal backfill, handling loads, operating loads and static loads imposed by equipment used in hoisting the pumps in and out of the station. All inside surfaces shall be smooth and free of cracks and crazing. The inside surface shall be pigmented or gel coated to a bright white finish. All surfaces other than those made in contact with the mold surface shall be coated with air-inhibited resin or gel coat; this includes any cut edges of laminate.

E. The bottom part, the inlet and the outlet connection pipes shall be laminated to the station cylinder. The station shall have an anti-flotation flange and be approved to withstand the full hydrostatic head from the exterior of the station and to withstand the forces acting upon the station due to the subsoil water pressure while the station is completely empty.

F. The manufacturer shall provide with the delivery a manual with detailed installation and safety instructions. The manual shall include information about the backfill material to provide adequate ballast against buoyancy under full hydrostatic head conditions.

G. The sloping walls of the pump station bottom shall transport all solids, trash and sludge, normally found in sewage and wastewater, to the suction of the submersible pumps to facilitate removal and effectively clean the bottom. The maximum volume left in the station after the pumps have stopped shall be 80 US gallons or 40 US gallons if the pumps are connected to an electronic sump cleaning device.

H. The discharge connections shall be mounted on a sloped wall so solids can't settle below the discharge pipes.

I. Lifting eyes and anchoring steel bars shall enable a quick and easy installation of the station.

J. The station must be protected against electrical shock according the IEC regulation 611 40.

K. The pump station shall be ready for operation and be furnished with following equipment:
   a. All fasteners shall be made of stainless steel AISI 316.
   b. 2x 6" discharge connections made of cast iron ASTM A-48, Class 35B with MULTI/JOINT coupling.

c. 2 x 2” guide bars per discharge connection made of stainless steel AIAI 316.
d. 2 upper guide bar holder made of stainless steel 316.
e. 2 x 6” discharge pipe made of PE 100, PVC or stainless steel 316. The length of the pipes shall be sufficient to connect these pipes to the valves in the valve vault.
f. 1 Cable holder with 4 hooks made in Stainless steel AISI 316.

L. The station cover shall be of ¼-inch thick Type-5086 aluminum diamond plate with an integral Safe-Hatch access cover. All bars, angles and shapes shall be type 6061-T6 aluminum. The access cover frame shall be a minimum of 4-inches deep and shall be adequately sized to allow for easy passage of the submersible pumps. The Safe-Hatch access cover shall be designed to support the weight of the pump unit plus pedestrian traffic. The access door(s) shall be equipped with a hold-open arm, held open in the 90-degree position. Cover door hinges shall be heavy-duty design and be cast 1/4-inch thick Type 316 stainless steel with 3/8-inch diameter stainless steel hinge pins. All fasteners shall be type-316 stainless steel. Each hatch shall be supplied with a type-316 stainless steel slam lock, having a key-way protected by a threaded plug. The plug shall be flush with the diamond plate cover. The hatch shall be equipped with an aluminum lift handle that shall be flush to the top of the diamond plate cover. The station lid shall have an integral four-inch diameter stub-pipe connection for the purpose of venting the pump station. The inverted J-shaped vent pipe shall be schedule 40 PVC pipe and shall end at a point at least 3-foot above the elevation of the station cover. There shall also be an option for a second vent to accommodate positive ventilation of the wet well. The access cover unit shall be equipped with a Safe-Hatch hinged safety grate to provide protection against fall-through and to control access into the confined space. Grate openings shall be sized to allow for routine maintenance inspection without having to open the safety grate. The closed safety grate shall be designed to support the weight of one pump to facilitate site pump wash-down and inspection. The hatch opening will have a 4” elevated toe board to prevent tools from being kicked into the wet well (per OSHA 1926.502)

2.2. VALVE VAULT

A. Each discharge pipe from the sewage pump station shall be connected to a check valve and a gate valve in a separate valve vault. The valve vault shall be fabricated in either concrete or FRP and shall be large enough to allow entry for routine maintenance and inspection. The valve vault shall be equipped with an integral drain and check valve to facilitate drainage from the valve vault back into the pump station.

B. The check valves shall be Ball-type or ValMatic flap-type. The gate valves shall be ¼-turn eccentric plug-type. All valves shall be made of cast iron with flanges according ANSI and be connected to a single 6” discharge pipe which shall last at least 5 feet outside the valve vault. The pipes shall be made of either of PE 100 or Stainless steel AISI 316.

C. The valve vault cover shall be of ¼-inch thick Type-5086 aluminum diamond plate with an integral Safe-Hatch access cover.

2.3. SUBMERSIBLE SEWAGE PUMPS (FLYGT NP 3127 LT OR MT OR EQUIVALENT)

A. Each station shall be equipped with **2** submersible, close-coupled wastewater pumps.

B. Each pump shall be equipped with a **10 HP** submersible electric motor, capable to operate on a **460** volt, 3 phases, 60 hertz voltage supply.

C. The hydraulic of the pump shall be capable of handling raw domestic wastewater and storm water with fibrous materials like wet wipes**.**

D. The impeller blades shall be self-cleaning upon each rotation as they pass across a sharp relief groove in the Insert ring and shall keep the impeller blades clear of debris. The insert ring shall have a guide pin which moves fibers from the center of the impeller to the leading edges of the impeller. The impeller shall move axially upwards to allow larger debris to pass through and immediately return to normal operating position. The clearance between the insert ring and the impeller leading edges shall be adjustable.

E. The impeller shall be wear resistant and made of high chromium cast iron with at least 24% chrome against sand and grit which is expected to enter the pump station with the sewage or the storm water. Impellers that have surface hardening (by thermal, coating, etc.) will not be allowed

F. The pump shall be capable to operate without any limitation between 50% and 125% of the Best efficiency point (B.E.P) of the performance curve.

	Flow in USgpm	TDH in feet	Hydraulic efficiency %	NPSHre in feet
Required Duty Point	271	48	50	12
Guaranteed duty point acc. HI <10kW B	To be filled in by supplier	To be filled in by supplier	To be filled in by supplier	To be filled in by supplier
Best efficiency point of offered pump (B.E.P.)	To be filled in by supplier	To be filled in by supplier	To be filled in by supplier	To be filled in by supplier

G. The required shaft power (P2) in the guaranteed duty point shall be less than **7.5 HP**. The motor speed shall be max. : **1800 rpm**. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output HP and efficiency. This chart shall also include data on starting and no-load characteristics

H. The impeller shall be mounted on the motor shaft. Couplings shall not be accepted.

I. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. It shall be permanently submersible according standard IEC 60034 and protection class IP 68.

J. The stator windings shall be insulated with moisture resistant Class H insulation rated for 356°F.

K. The motor shall be capable of no less than 30 evenly spaced starts per hour and be able to operate throughout the entire pump performance curve from shut-off through run-out even when the motor is not submerged

L. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable.

M. It shall be possible to lift and lower the pumps on parallel guide bars and connect them to wet well mounted discharge connection. There shall be no need for personal to enter the wet well when removing or reinstalling the pumps.

N. The pump housing shall be prepared for the assembling of a sump mixing valve. The discharge flange of the pump housing shall be 4”.

O. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomeric compression seal. Connection between the cable conductors and

stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

P. The motor shall be protected by 3 thermal switches embedded in the stator set to open at 260°F and one leakage sensor floating type located in the stator chamber. The sensor and the switches shall be connected to the control panel which shall stop the motor and send an alarm when the sensors are activated.

Q. The pump shall be Explosion approved according FM CLASS 1. DIV 1 "C" & "D"

R. The cable entry shall consist of dual cylindrical elastomer sleeves, flanked by washers, all having a close tolerance fit against the cable and the cable entry. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

S. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated and have a nominal L10 lifetime of 50.000 hours. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

T. The shaft shall be sealed by a tandem mechanical shaft seal system consisting of two seals, each having an independent spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal function.

U. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. Seal lubricant shall be non-hazardous.

V. Where a seal cavity is present in the seal chamber, the area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

W. The Materials of construction shall be as follows:

   a. Pump housing: ASTM A-48, Class 35B
   b. Impeller and insert ring: A 532 ALLOY III A (25% Chrome)
   c. Stator housing: ASTM A-48, Class 35B
   d. Shaft: ASTM A479 S43100-T.
   e. Shaft seal: Pump side: - Corrosion resistant Tungsten carbide WCCR
   f. Shaft seal Motor side: - Corrosion resistant Tungsten carbide WCCR

X. All castings must be blasted before coating. All wet surfaces are to be coated with two-pack oxyrane ester Duasolid 50. The total layer thickness should be at least 120 microns. Zink dust primer shall not be used.

Y. The motor shall be equipped with 30 feet of screened cable suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards. The outer

jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

Z. Each completed and assembled pump/motor unit shall undergo the following factory tests at the manufacturer's plant prior to shipment. The Manufacturer shall provide on demand a copy of his quality control plan for these tests and an ISO 9001 factory certificate:

a. Minimum 3-point hydraulic performance test
b. No-Leak seal integrity test
c. Electrical integrity test

2.4. LIFTING EQUIPMENT FOR PUMPS

A. Each pump shall be fitted with stainless steel lifting chain or lifting cable of sufficient length to lower the pump into position. The working load of the lifting system shall be 50% greater than the pump unit weight.

2.5. SUMP MIXING VAVLE (FLYGT 4901 0R EQUIVALENT)

A. One pump unit in each pump station shall be equipped with an automatically operating flush valve mounted directly to the pump volute. During the starting the valve shall redirect a portion of the pumped media into the sump to re-suspend solids and grease by the turbulent action of its discharge.

B. The valve shall be equipped with an adjustable, wear-resistant discharge nozzle that can be used to direct flow within the sump. The valve shall operate by differential pressure across the valve and shall not require any electric or pneumatic power source to operate. The valve shall be suitable for use in Class I, Division 1 hazardous locations.

C. The valve shall open at the beginning of each pumping cycle and shall automatically close during the pump operation after a pre-set time. A method of adjusting the valve operating time shall be provided.

2.6. SUBMERSIBLE CABLE CONNECTION BOX ACC. NEMA 6P (IP 68) (INTEX, RALSTON OR SIMILAR)

A. The submersible cable of the pump shall be connected to the cable from the Control panel in a floor or wall mounted cable connection box to ease the installation and disassembling of the pumps and keep the submersible cables as short as possible.

B. The cable connection box shall be submersible NEMA 6P (IP 68) to secure that no water can enter the motor via the cables even when the complete area is flooded.

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SUMMARY

A. Work Included:
1. Installation of pipe material.
2. Construction of drainage system structures including curb inlets, junction boxes and catch basins.
3. Ditch-out for storm drainage system discharge.

B. Related Work Specified in Other Sections
1. Section 31 23 33 - Trenching and Backfilling
2. Section 31 00 00 - Earthwork

1.03 COORDINATION

A. Contractor shall coordinate installation of drainage system with other construction throughout the site.

B. All construction shall conform to applicable City Specifications for Construction.

C. All work of this Section shall be completed within the limits of the site property boundary or designated offsite easements.

1.04 REFERENCES

A. ASTM C76: Specification for Reinforced Concrete Pipe.
B. AASHTO M294 HDPE Pipe
C. ASTM F477 HDPE Fittings

1.05 SUBMITTALS

A. All pipe and fittings not covered by this specification shall be approved by the engineer seven days prior to bid.

PART 2 - PRODUCTS

2.01 PIPE

A. Reinforced concrete pipe shall be Class III.

B. Plastic pipe shall be PVC SDR35 or Schedule 40 or HDPE heavy wall meeting the requirements of AASHTO M294 and ASTM F477 with corrugated exterior with smooth lined interior. All pipe joints and all fittings shall be watertight.

C. ADS HP Storm polypropylene pipe (dual wall) meeting the requirements of AASHTO M330, ASTM F2736 and ASTM F2881 with smooth inner wall and annular exterior corrugations.

2.02 DRAINAGE STRUCTURES

A. Materials for the construction of inlets and junction boxes shall be as specified in Division 7, "Structures" of the NCTCOG's Standard Specifications for Construction.

PART 3 - EXECUTION

3.01 GENERAL

A. The locations of all structures and lines and grades of all pipes shall be staked by a registered surveyor. All facilities shall be located according to the site layout plans.

B. Contractor shall utilize necessary measures, including temporary pumping in order to drain storm water offsite until the public drainage improvements are installed and operational.

3.02 PIPES

A. All pipes shall be inspected prior to installation. Damaged pipes shall not be used. Replacement of damaged pipe shall be made by the Contractor at no expense to the owner.

B. Installation shall be in accordance with ASTM D2321 and as recommended by the pipe manufacturer. Backfill shall be ASTM D2321 Class I, II or III soils.

C. Pipe installation shall conform to the North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction & City specifications.

D. Concrete collars shall be constructed where there is a change in pipe material

3.03 DRAINAGE STRUCTURES

A. Construction of curb inlets tops and catch basins in pavement areas shall be **cast-in-place only** with **no precast structures allowed.** All manholes in pavement area shall be held below pavement and the frame/lid shall be adjusted to final grade with grade rings. There should be no abrupt grade changes at manhole rims. **If abrupt grade changes are present, grade adjustments will be required.** Catch basins and headwalls outside of pavement areas shall either be cast-in-place or precast.

B. Connections of pipe to structures shall be completely mortared around the perimeter of the pipe to ensure watertight connection to the structure prior to backfilling. All bends and tees shall be precast/preformed.

C. Inlet top and throat shall be poured once pavement improvements are in place.

END OF SECTION

VLK | ARCHITECTS

AUSTIN DALLAS EL PASO FORT WORTH HOUSTON