PROJECT MANUAL VOLUME 2

MAY 28, 2025

EMS ISD Agricultural Science Complex

EAGLE MOUNTAIN-SAGINAW ISD

FORT WORTH, TEXAS

VLK Project No.

24-057.00

OWNER:

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

OWNER

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

ARCHITECT

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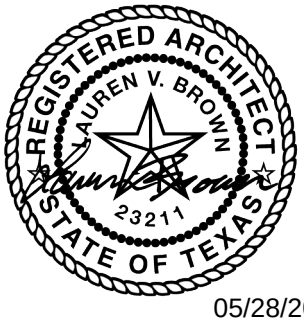
Fort Worth, Texas 76104
Phone: 817.633.1600
www.vlkarchitects.com



05/28/2025

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Fort Worth, Texas 76137
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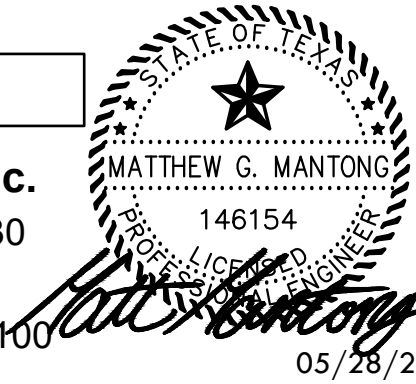

05/28/2025

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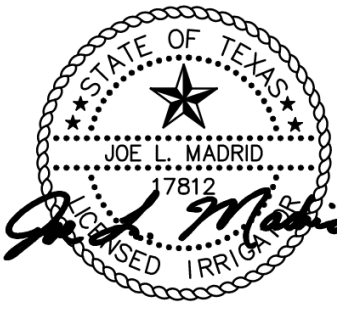

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FOOD SERVICE

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Lance Brooks
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MECHANICAL ENGINEER

ELECTRICAL ENGINEER

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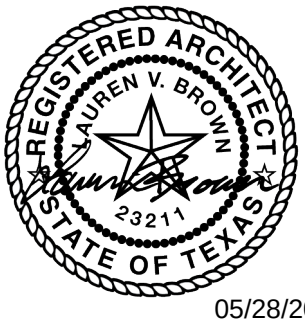

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00 31 32 - Geotechnical Data

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NONE IN THIS PROJECT

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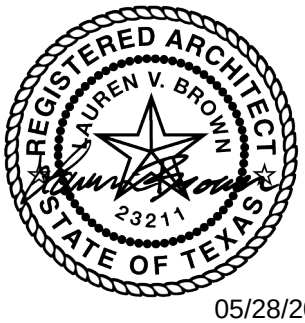

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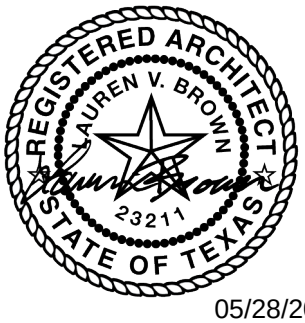

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NONE IN THIS PROJECT

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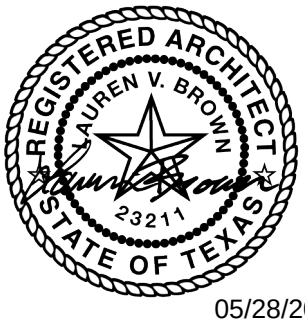

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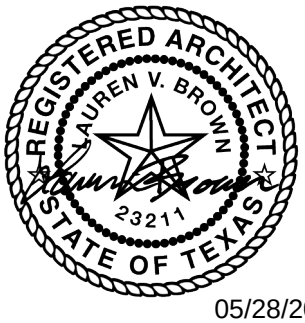
DIVISION 26 - ELECTRICAL



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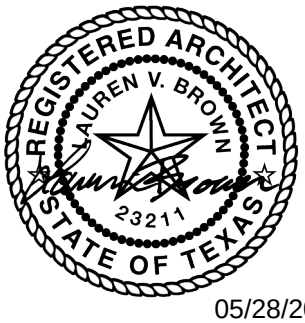

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DIVISION 48 - ELECTRICAL POWER GENERATION

NONE IN THIS PROJECT

DIVISION 49 - Not used.

SECTION 21 05 00

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 ensure

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 fire protection systems. Operating instructions shall include recommended maintenance and testing 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 equipment, devices 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. 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.

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.

1.16 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 Fire Sprinkler 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, valve assemblies, and devices.

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 systems installations. Prior to this walk-thru, all work specified in this Division shall have been completed and tested, 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. 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 operating as intended, 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 where shown on the Drawings, where required by NFPA 14, local codes and amendments, and 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 exact location of the Fire Department Connection shall be coordinated between the installing contractor and the local AHJ. The location noted on the documents is shown for reference only. The installing contractor shall provide all labor and material as required in order to accommodate the location required by the local AHJ.

C. The Classification of Fire Department Valve/Standpipe System shall be as required by Local AHJ, Owner’s Insurance Carrier and NFPA 14.

D. 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, 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.

E. 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.

A. The Main Building Sprinkler Systems shall be fed by one (1) automatic wet sprinkler and one (1) dry valve (Refer to 21 1335) assemblies. The Animal Building shall be fed by one (1) dry valve assembly (Refer to 21 1335). Each wet system shall be limited to a maximum of 52,000 square feet per floor for Light & Ordinary Hazard and 40,000 square feet per floor for Extra Hazard and High Pile Storage 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.

B. The Fire Department Hose Valves, Cabinets, and Standpipes shall meet the requirements of NFPA 14, local codes and amendments, and as indicated and where required by the local Fire Department. The exact locations and quantities of the required fire department valves and cabinets are not shown on the drawings. Any Fire Department Valves and Cabinets noted within the drawings are shown only for

reference. Valve Cabinets shall be as specified herein and exact locations shall be coordinated with the Architect and Architectural drawings. 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 or 100 gpm at 65 psig for Class II standpipes 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.

C. 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 [for the basis of design of the hydraulically calculated system.

D. 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.

E. 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.

F. 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).

G. 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, and owner’s technical design guidelines 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 most current North America Free Trade Agreement, NAFTA/USMCA.

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, 14 and 24.

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
Sprinklers	X	X	
Valves	X	X	
Hangers	X	X	
Jointing Method	X		
System Layout		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 In-Building Riser Model "IBR Series".

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

C. Above Grade, Indoor Piping: Pipe Size 1-1/2 Inch and Smaller shall be 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 shall be: Class 150 malleable iron, threaded fittings, ANSI B16.3.
2. Acceptable manufacturers: Tyco, or Anvil.

D. Above Grade, Indoor Piping: Pipe Size 2 Inch and Larger shall be 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 shall be: UL listed, FM approved mechanical grooved couplings with flush sealed gasket style equal to Victaulic "AWWA Flush Seal".
2. Acceptable manufacturers: Victaulic, Tyco, or Anvil.

E. No Mechanical Tees shall be installed.

F. No "EDDYFLOW" or "EDDYTHREAD" pipe shall be installed.

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

H. 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.

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 or Viking.

NOTE: Sprinklers shall be limited to 400 sq. ft. coverage for light hazard and 130 sq. ft. for ordinary hazard area.

CONCEALED SPRINKLER COVER PLATES OR UPRIGHT SPRINKLERS IN SPECIALITY CEILING FINISHES SHALL BE FACTORY PAINTED TO MATCH CEILING COLOR. CONTRACTOR SHALL SUBMIT COLOR SELECTIONS TO ARCHITECT FOR APPROVAL PRIOR TO ORDERING SPRINKLER COVER PLATE.

1. Provide fully concealed pendent type in all finished areas with ceiling or soffit with factory painted "off-white" threaded cover plate equal to Tyco Quick Response concealed sprinkler model RFII “Royal Flush II”. Where ceiling finishes are anything besides “off-white”, the cover plates shall be factory painted to match the ceiling finishes. Contractor shall submit color selections to Architect for approval prior to ordering sprinkler cover plate.
2. 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).
3. Provide upright extended coverage quick response sprinklers Tyco Model EC-5 or EC-8 only where indicated on the plans.
4. Provide chrome plated brass recessed pendant sprinkler with chrome plate escutcheon (in occupied areas) equal to Tyco TY-FRB.
5. Provide in heated spaces only exposed chrome plated horizontal and vertical side wall sprinklers equal to Tyco-TY-FRL.
6. Provide in heated spaces only, recessed chrome plated horizontal sidewall sprinklers equal to TYCO series EC.

B. Sprinklers in non-heated outside storage rooms, and covered loading dock shall be Tyco Model DS-1 dry horizontal sidewall sprinkler heads factory painted to match ceiling. Provide length of pre-charged riser as required to keep wet section of piping in heated space. Equivalent sprinkler heads by Reliable or Viking will be acceptable.

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 heads where exposed in the Locker Room and where sprinklers are installed at or below 8'-0". Cage guards shall be a UL listed and engineered products which shall be listed by the sprinkler manufacture for specific use on the exact sprinkler installed.

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 or Water-Motor Gong (As required by local AHJ): Provide wall mounted weatherproof, red finished, 120V exterior horn/strobe UL listed FM approval with back box equal to Potter SH-120 Series or Provide a 10” weatherproof, red enameled finish, water-motor gong, UL listed, FM approved equal to Tyco WMA-1.

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. Outside Fire Department Connections:

1. The exact location of the Fire Department Connection shall be coordinated between the installing contractor and the local AHJ. The location noted on the documents is shown for reference only. The installing contractor shall provide all labor and material as required in order to accommodate the location required by the local AHJ.
2. Flush (wall) type devices shall be equal to Potter-Roemer No. 5124, 2-way, Fire Department Connection with individual drop clapper valves, plugs, chain, and escutcheon letters “AUTO.SPRK”. 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.
3. 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.

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 (WHERE REQUIRED BY LOCAL AHJ)

A. The Fire Department Hose Valves, Cabinets, and Standpipes shall meet the requirements of NFPA 14, local codes and amendments, and as indicated and where required by the local Fire Department. The exact locations and quantities of the required fire department valves and cabinets are not shown on the drawings. Any Fire Department Valves and Cabinets noted within the drawings are shown only for reference. Contractor shall coordinate exact locations of valve cabinets with the Architect and Architectural drawings. Provide fire department valve/standpipe classification as required by the local AHJ.

B. 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.

C. Valve in Cabinet: Potter-Roemer 4000 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 cap with pin lug with threads suitable for connection of local fire department hoses and chain.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install combined standpipe and automatic sprinkler system where shown on the Drawings or as noted herein. 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. No Mechanical Tees shall be installed.

E. No “EDDYFLOW” or “EDDYTHREAD” pipe shall be installed.

F. 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.

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

H. Install automatic air vents at the high points of the sprinkler piping.

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

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

K. Thrust blocks shall comply with NFPA 24 and shall be of size required for the soil bearing strength and against compacted soil.

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

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

N. 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.

O. 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.

P. Riser Nipple and Arm Overs to sprinklers shall be installed off branch piping with a return bend. This installation shall comply with the method as described in NFPA 13.

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 21 13 35

DRY PIPE FIRE SPRINKLER 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 DESCRIPTION

A. Provide labor, new materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of one dry pipe sprinkler system unheated spaces for the Show Arena Building and one dry system for the entire Animal Building Facility. This contractor shall include all electronic monitoring switches for valve supervision and water flow. The dry sprinkler system shall protect the entire building.

B. The exact location of the Fire Department Connection shall be coordinated between the installing contractor and the local AHJ. The location noted on the documents is shown for reference only. The installing contractor shall provide all labor and material as required in order to accommodate the location required by the 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, drum drip drains, and sprinklers, stainless steel backflow preventer assembly (will be provided by the Civil Engineer on site in a vault) and inside Fire Department valve connections as required by local authorities. The total extent of fire sprinkler piping work is not indicated by drawings.

D. A sprinkler layout is not shown on the plans. The successful Contractor shall prepare shop drawings for the hydraulically designed sprinkler system using an Automatic Nitrogen Maintenance devices and Nitrogen Generation Systems to achieve Nitrogen as the monitoring gas for the system and secure approval of same from Owner’s Insurance Carrier, Local Authorities. Approved plans and calculations shall be submitted to the Architect for approval before any materials are fabricated.

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

1. The sprinkler systems shall be designed to meet the hydraulically most remote requirements of 0.15 gpm/sq.ft. for 1,500 sq.ft. throughout the structure.
2. A 10 psig safety factor shall be designed into all the hydraulic calculations.
3. The maximum velocity in the pipes shall not exceed 32 ft/sec.
4. Head spacing shall be 130 sq. ft. maximum.
5. A main drain shall be provided next to the main sprinkler/standpipe riser.
6. The inspectors test shall be located at the most remote portion of the systems and the trip test shall not exceed 60 seconds.
7. The piping shall be pitched toward the main or auxiliary drain. Branch lines shall be pitched at least 1/2 inch per 10 ft. and cross mains shall be pitched at least 1/4 inch per 10 ft.
8. If any system exceeds 500 gallons capacity, provide a quick opening device.
9. The sprinkler system shall be designed 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).

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 most current North America Free Trade Agreement, NAFTA/USMCA**.

1.4 GOVERNING AUTHORITIES

A. The system shall comply with applicable State and City codes, with the requirements of other authorities having jurisdiction, and with the requirements of the Local Building Code, Local Fire Code, and NFPA 13 and 14. Where codes conflict the most stringent shall apply.

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 the fire protection system to, and receive approval from, the governing authorities before installation work is started. Refer to Section 21 05 00 and appropriate Architectural section.

B. Submit to the Architect, upon completion of each system, a certificate stating that the work has been completed and tested in accordance with applicable standards, 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 unless otherwise directed by the governing authorities.

C. Submit to the Architect 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		
Nitrogen Generator	X	X	
Piping	X	X	
System Layout		X	
MIC Treatment	X	X	

1.6 MAINTENANCE STOCK, FIRE SPRINKLERS

A. Maintenance Stock: For each style and temperature range required, furnish an additional two (2) fire sprinklers for every 100 units installed, but not less than six (6) units of each different type.

1.7 COORDINATION

A. The Contractor shall examine all other work shown on the drawings and such work installed at the job site. The sprinkler system Contractor shall coordinate the routing of his work with the other construction trades to avoid interference with the other installations. Mechanical duct work and light fixtures shall have preference over sprinkler piping.

B. Pipe routing shall be located as required to avoid equipment, plumbing drain pipe, heating and air conditioning piping, duct work, light fixtures, and electrical buss ducts. This 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 05 00.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall comply with the requirements of this section, NFPA 13, Owner’s Insurance Carrier, UL, 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 In-Building Riser Model “IBR Series”. The dimensions of the

assembly shall be coordinated with structural foundations and the location of the vertical connection in the riser room.

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

C. Above Grade, Indoor Piping 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. Pipe Size 1-1/2 Inch and Smaller: Class 150 malleable iron, threaded fittings, ANSI B16.3.
2. Fittings: Acceptable manufacturers: Tyco, or Anvil.

D. Above Grade, Indoor Piping 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. Size 2 Inch and Larger: UL listed mechanical grooved couplings with flush sealed gasket style equal to Victaulic “AWWA Flush Seal”.
Fittings: Acceptable manufacturers: Victaulic, Tyco, or Anvil.

E. **No Mechanical Tees shall be installed**.

F. **No “EDDYFLOW” or “EDDYTHREAD” pipe shall be installed.**

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 NFPA 13.

B. General: Conform to the requirements NFPA 13.

C. Dry Pipe Valves: Provide Tyco DPV-1 with trim or equivalent.

D. Check Valves: ProvideTyco Model CV-1F or equivalent.

E. 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.

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 or Viking.

B. NOTE: Sprinklers shall be limited to 225 sq. ft. coverage for light hazard and 130 sq. ft. for ordinary hazard area:

CONCEALED SPRINKLER COVER PLATES OR UPRIGHT SPRINKLERS IN SPECIALITY CEILING FINISHES SHALL BE FACTORY PAINTED TO MATCH CEILING COLOR. CONTRACTOR SHALL SUBMIT COLOR SELECTIONS TO ARCHITECT FOR APPROVAL PRIOR TO ORDERING SPRINKLER COVER PLATE.

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. Tyco model DS-C concealed adjustable sprinkler with “off-white” cover plate, with length pre-charged riser as required to keep sprinkler drop from main dry in accidental. Where ceiling finishes are anything besides “off-white”, the cover plates shall be factory painted to match the ceiling finishes. Contractor shall submit color selections to Architect for approval prior to ordering sprinkler cover plate.
3. Tyco model DS upright sprinklers, with length pre-charged riser as required to keep sprinkler drop from main dry in accidental.

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.

2.6 CORROSION MANAGEMENT PRODUCTS

A. Nitrogen Generation System:

1. The fire sprinkler contractor shall furnish and install the Nitrogen Generation System at the location(s) indicated on the design documents or as directed by the design engineer. Install per manufacturer’s instructions. The nitrogen generator shall be sized based up the total fire protection system volume to be served.
2. The Nitrogen Generation System must be installed with a compressor sized appropriately for the application and capable of achieving system pressure within 30 minutes in accordance with NFPA 13. When the Nitrogen Generation System and the compressor are serving more than a single fire protection system, a larger capacity compressor may be required.
3. The Nitrogen Generation System shall be designed to achieve a nitrogen concentration of 98% or greater and maintain that concentration within the fire protection system continuously.
4. The fire sprinkler contractor shall install the provide NFPA 13 compliant Nitrogen Generation System Automatic AirVents installed in the location required by NFPA & nitrogen generator manufacturer. Acceptable product, ECS PAV-D or pre-approved equal.
5. Acceptable manufacturers: Engineer Corrosion Solutions (ECS), Tyco, or Potter.

B. Air Compressor

1. Furnish and install an air compressor to serve the fire protection system and the Nitrogen Generation System. The air compressor shall have a dedicated unswitched power source of 110v or 220v (as required by the air compressor manufacturer).
2. Air compressor shall be rated by the manufacturer for continuous duty service.
3. Air compressor shall have an output pressure rating of at least 100 psi.
4. Air compressor shall be capable of producing a continuous volume of compressed air that is sufficient to meet the design requirements of the fire protection system and the Nitrogen Generation System.
5. Air compressor shall be equipped with an air receiver tank of at least 20 gallons.
6. Air compressor shall be equipped with an automatic blow down device that automatically empties condensed water from the air receiver tank. This water discharge shall be piped to a drain.
7. Air compressor shall be connected to the Nitrogen Generator and from the Nitrogen Generation System to the fire protection systems air maintenance device with metal piping that is at least 1/2 in. diameter.
8. For smaller systems, the air compressor shall be integral with the Nitrogen Generator.

C. Air Maintenance Device

1. Air Maintenance Device shall be equipped with a field adjustable pressure regulator for use in setting the maximum system pressure.
2. Air Maintenance Device shall be installed per the manufacturer’s instructions.
3. Acceptable products: Tyco AMD-1, Reliable Model A, or Victaulic Series 757.

D. Corrosion Monitoring Station:

1. Furnish and install Corrosion Monitoring Station for each automatic sprinkler system provided in the project or at the locations indicated on the design documents when shown. Install per manufacturer's instructions. The fire sprinkler contractor shall confirm that the manufacturer installed corrosion monitoring coupons and the Corrosion Monitoring Probe when specified, are installed in the monitoring station when received. Verification shall be made by viewing the devices through the sight glasses at the ends of the monitoring. The contractor shall not remove the corrosion monitoring probe or corrosion monitoring coupons from the monitoring station during the installation process.
2. Install the Corrosion Monitoring Station on the system side of the flow switch and a minimum of 3 feet from the system control valve.
3. After the installation of the Corrosion Monitoring Station and the Corrosion Monitoring Probe, when specified, the isolation valve to the sprinkler system shall be placed in the open position including when filling the system for final hydrostatic testing or any testing allowing water flow into the sprinkler system.
4. Corrosion Monitoring Station is assembled by the manufacturer and only requires the contractor to connect two (2) parts at the provided coupling to achieve full assembly.

E. Corrosion Monitoring Probe:

1. Furnish and install s Corrosion Monitoring Probe, at each of the provided Corrosion Monitoring Station. Install per manufacturer's instructions.
2. The fire sprinkler contractor shall confirm that the corrosion monitoring probe for each sprinkler system is installed in each monitoring station; the detector will be installed by the manufacturer when it is ordered with the Corrosion Monitoring Station. Verification shall be made by viewing the devices through the sight glasses at the ends of the monitoring station. The contractor shall not remove the monitoring probe or corrosion monitoring coupons from the monitoring during the installation process.
3. Connect the Corrosion Monitoring Probe to a dedicated supervisory circuit on the building dedicated function fire sprinkler monitoring panel.

2.7 ACCESSORIES

A. Tamper Switches: Provide Potter Model PS10-1 or equivalent on all control valves, if one does not come with valve, for connection to the fire alarm system.

B. Water Flow Detectors: Provide Potter Model PS40A/HLS-2-40 pressure switch or equivalent. Provide a water flow detector for each system.

C. Pressure Gauges: Provide 3-1/3 inch diameter, Allenco No. 1700 pressure gauges with stainless steel case and with a range of 0-300 psig, include gauge cock at the top of each riser and on either side of the floor control valve.

D. Supervisory Air Maintenance Device: Provide FM approved reducing type supervisory air maintenance device equal to Tyco model F114.

E. Wall Mounted Weather-Proof Horn/Strobe or Water-Motor Gong (As required by local AHJ): Provide wall mounted weatherproof, red finished, 120V exterior horn/strobe UL listed FM approval with back box equal to Potter SH-120 Series or Provide a 10" weatherproof, red enameled finish, water-motor gong, UL listed, FM approved equal to Tyco WMA-1.

F. 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.

G. Drum Drip Assembly: Provide where required by NFPA 13 and 25 compliant, UL listed, will full brass quarter-turn ball valve with NFPA compliant signage and excessive flow valve (FloodEliminator AGF 5900). Acceptable product: AGF Manufacturing, Inc, 5300 Series or approved equal.

H. 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.

I. Outside Fire Department Connections:

1. The exact location of the Fire Department Connection shall be coordinated between the installing contractor and the local AHJ. The location noted on the documents is shown for reference only. The installing contractor shall provide all labor and material as required in order to accommodate the location required by the local AHJ.
2. Flush (wall) type devices shall be equal to Potter-Roemer No. 5124, 2-way, Fire Department Connection with individual drop clapper valves, plugs, chain, and escutcheon letters “AUTO.SPRK”. 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.
3. 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

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

K. Relief Valves: Provide pressure relief valves as required by NFPA 13.

2.8 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 or MDF Rooms.

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

2.9 PENETRATION SEALS

A. Where sprinkler piping penetrates fire barriers and/or smoke barriers seal with a Factory Mutual listed fire stop system. In addition, smoke barrier penetrations shall be caulked to prevent the passage of smoke. Pipe passing through walls shall be sleeved with a 16 ga. galvanized steel sleeve. The sleeve and annular space between the pipe and sleeve shall be sealed with fire rated sealant

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install automatic sprinkler and standpipe system where shown on the Drawings or as specified. Installation shall comply with the requirements of Local Building Code and Standards, Local Fire Code, NFPA 13, 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. 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 a tamper switch on each sectional valve and on each other shut-off valve.

F. Install main drain at riser and auxiliary drain piping at all low points of the sprinkler piping as required by NFPA 13.

G. Install heads in all locations, pendant or upright, as required.

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

I. Thrust blocks shall comply with NFPA 24 and 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. Riser Nipple and Arm Overs to sprinklers shall be installed off branch piping with a return bend. This installation shall comply with the method as described in NFPA 13.

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 Architect 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. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

3.4 TESTS

A. Pneumatically test all pipe for leaks at a minimum 40 psi for 24 hours before hydrostatic testing of the pipe. Any leakage that results in a loss of pressure in excess of 1-1/2 psi for 24 hours shall be corrected.

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

C. 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 Architect a statement that all requirements of Factory Mutual, the Texas Department of Insurance, City Building Inspection and Fire Departments have been met in the installation of the fire protection systems.

END OF SECTION

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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.

C. Contractor shall comply with the most current Eagle Mountain Saginaw ISD Technical Design Guidelines.

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 Section 01 73 10, 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 Section 01 70 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 70 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 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. An electronic copy of each shall be submitted. Additional copies will be required when indicated by the Architect and as required for project coordination.

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 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.

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.

D. In general, piping shall be run parallel or perpendicular to the lines of the building. No plumbing piping shall be installed in or pass through transformer vaults, elevator machine rooms, electrical rooms, telephone rooms, MDF room, or IDF room.

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 most current “Buy America” Act formally known as 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 Section 03 30 00, 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 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 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.

C. Contractor shall use native soils to backfill where pipes pass under exterior grade beams.

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 33

HEAT TRACING FOR PLUMBING 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 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 22 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 22 05 00.

PART 2 - PRODUCTS

2.1 SELF REGULATING HEAT TRACE

A. Furnish and install self-regulating rapid-trace heating cable.

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. Domestic Hot & Cold Water

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 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,

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 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING 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 22 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 22 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 22 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 22 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. For equipment that is 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. 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. 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.

E. Boilers, water heaters, or other equipment to be installed on housekeeping pads shall be mounted on ribbed neoprene pads equal to Amber Booth Ampad Type NR or NRC, Style B isolators.

2.3 MANUFACTURER

A. Isolating materials used shall be equivalent to Amber-Booth (The VMC Group), Korfund Dynamics (The VMC Group), Vibro-Acoustics or Mason Industries.

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

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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 UTILITY MARKING

A. At all above ceiling locations the contractor shall, at the end of construction, mark the ceiling tile grid with a self-adhesive ceiling markers. Use a Seton Ceiling Markers. Mark as follows:

1. Domestic Cold Water Valves – Single Blue Dot.
2. Domestic Hot Water Valves & Venturi Valves – Single Yellow Dot.
3. Natural Gas Valves – Single Orange Dot.
4. Fire Dampers – Single Red Dot (Marked on Wall Mold under Damper)
5. HVAC Controllers – Double Green Dot
6. VAV Boxes – Single Green Dot
7. HVAC Chilled Water Valves – Double Blue Dot
8. HVAC Heating Water Valves – Double Yellow Dot
9. Duct Smoke Detectors – Double Red Dot.

B. Street curbs - At all location where utilities cross under sidewalks or roadways the contractor shall stamp the concrete as follows:

1. Fire Lines - F (Provide a “V” in the direction of flow).
2. Water Lines - W (Provide a “V” in the direction of flow).
3. Natural Gas Lines - G (Provide a “V” in the direction of lfow).
4. Sanitary Sewer Lines - SS (Provide a “V” in the direction of flow).
5. Storm Drain Lines - SD (Provide a “V” in the direction of flow).

2.2 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. Domestic Hot Water Return (Orange background)
4. 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.
5. Storm Sewer (Green background)
6. Sanitary Sewer (Green background)
7. Sprinkler Piping (Red background)
8. Natural Gas (Yellow background)
9. Non-Potable Water (Purple background)

2.3 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.
3. Boilers.
4. Thermostatic Mixing Valves
5. Storage Tanks

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.

2.4 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 a framed valve tag charts with typed schedule sheets and valve tag map contained therein. Charts and map shall have an aluminum frame with clear plastic or lexan window. This shall be located in the Main Riser or Mechanical Room.

2.5 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 all underground polyethylene or polypropylene systems. Including but not limited to natural gas piping systems, sanitary sewer, storm drainage, site fire & domestic water.

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. Provide color coded marking tape impervious to all know alkalis, acids, chemical reagents and solvents likely to be encounter in the soil. The marking tape shall indicate the type of line buried below. Refer to manufacturer’s recommendations for additional requirements for buried tape. Marking Tape shall be equal to TERRAM detectable tapes.

2.6 NON-POTABLE SYSTEM AND EQUIPMENT IDENTIFICATION

A. Non-potable water outlets, such as hose connections, open-ended pipes and faucets, shall be identified with signage that reads as follows: “Non-potable water is utilized for lab use. CAUTION:

NONPOTABLE WATER – DO NOT DRINK." The words shall be legibly and indelibly printed on a tag or sign constructed of corrosion-resistant waterproof material or shall be indelibly printed on the fixture. The letters of the words shall be not less than 0.5 inch in height and in colors in contrast to the background on which they are applied. In addition to the required wordage, the pictograph shown below shall appear on the required signage. Signage shall be laminated self-adhesive Vinyl. Acceptable manufacturer: Seton L12030EEHTEDVAD.

B. Contractor shall coordinate the exact location of signage installation with Architect and Owner prior to installation.

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, at each change of direction but not more than 4 feet in each direction from each elbow and tee, and at each point where the piping passes through a wall, floor or roof. Markers not required on piping runouts less than four feet (4') in length and 1-1/4" or smaller in size.

C. Non-potable distribution piping shall be installed with a purple identification wrap. Pipe identification shall include the contents of the piping system and an arrow indicating the direction of flow. Hazardous piping systems shall also contain information addressing the nature of the hazard. Pipe identification shall be repeated at intervals not exceeding 20 feet and at each point where the piping passes through a wall, floor or roof. Lettering shall be readily observable within the room or space where the piping is located.

D. 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.

E. Install markers on exposed piping systems only after jacketing systems are complete. Refer to 22 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 ASSET TAGS

A. Each subcontractor will be furnished an excel spreadsheet, which has specific information that EMS ISD wants to associate with each piece of equipment. This will include information such as equipment ID tag, location, type of equipment, model number and serial number as a minimum.

B. The contractor shall complete the spreadsheet and shall submit the speadsheet for review of completeness. If not complete it will be returned with comments to be addressed and corrected by the contractor. This repeats until this list is accepted and approved.

C. The list will then be given to EMS ISD who will generate asset tags per the lists received. The plumbing subcontractor shall install the tags on their respective equipment. Tags need installed in easy to see locations and where they are least likely to be damaged or defaced.

D. Plumbing equipment would include:

1. Water heaters/Boilers
2. Circulation pumps
3. Booster Pump
4. Large thermostatic mixing valves
5. Backflow preventers.

3.4 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. Provide a framed valve tag charts with typed schedule sheets and valve tag map contained therein. Charts and map shall have an aluminum frame with clear plastic or lexan window. This shall be located in the Main Riser or Mechanical Room.

C. The contractor shall provide a color coded valve tag map correlated with the valve tag chart.

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

END OF SECTION

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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 30-33, Childers CP-33 vapor barrier coating, or approved equivalent. Vapor barriers- coatings shall have a maximum permeance rating of 0.07 at 43 mils dry film thickness per ASTM E-96, 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. 30-33, Childers CP-33 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 1-1/4"	1-1/2" 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	1.50	1.50
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-33 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.
3. Primary Roof Drainage System: All horizontal and vertical primary storm drainage piping to the point of penetration to the underfloor. 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.

4. Overflow Roof Drainage System: 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.
5. Refer to PART 3 – EXECUTION for add installation requirements for storm and overflow drain bodies.

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.

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 Foster 30-35. 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 No. 30-36, Childers CP-50, or by other approved methods. Adhesives shall have mold and mildew inhibitors.

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.

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. Roof and Overflow Drain Bodies:

1. Provide 12”x1” jacketed fiberglass pipe insulation on the upper section of the roof drain body. Provide additional pipe insulation, 10”x1” into the 12”x1” insulation, 8”x1” into the 10”x1”, etc. until a telescopic reducing bushing is created to match the actual pipe size.
2. Fill voids around drain body and underdeck collar with Owen Corning, or equal fiberglass batt insulation, minimum R-22.
3. Measure and cut Manson Insulation “AK Board” to fit the outside diameter of the underdeck collar and interior diameter of the insulated drain line.
4. Slit AK Board and fit into place, sealing split with 3M Aluminum Foil Tape.
5. Seal & Paint entire jacketed drain body with Childers CP-11 white mastic.

Q. 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 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. 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.

C. Unless otherwise noted for specific products, all material shall be manufactured in the United States and/or shall comply with the most current “Buy America” Act formally known as the North America Free Trade Agreement, NAFTA.

1. Trap Primer manufacturers do not need to comply with the most current “Buy America” Act.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Above ground (For Heated Envelope Locations):

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. Joints:

1) No lead containing solder is allowed.
2) Soldering:

a) 95% tin - 5% antimony for pipe sizes 2" and less.
b) Or 95.5% tin, 4% copper and 0.5% silver based for pipe sizes 2" and less.

3) Brazing:

a) "Silfos" for brazing pipe sizes 2-1/2" and larger.

d. Alternative jointing method for pipes 2" and smaller.

1) Type L copper pressed end fitting conforming to ASTM B88/B16.22 and NSF 61 Annex G.
2) Acceptable manufactures: Viega “Pro-Press”.
3) At completion of the project the contractor shall provide the Owner with complete set of clamping jaws and driver.

B. Above ground (For Non-Heated Envelope Locations):

1. 2 Inch and Smaller:

a. Pipe: PEX silane cross-linked high density polyethylene plastic according to ASTM F 876, ASTM F 877 and CSA B 137.5, NSF 14 & 61 certified, UV protected,
b. Fittings:

1) 2 Inch and smaller, PEX Press Fittings manufactured from Radel®-R PPSU polymer, meeting the requirements of ASTM F 3348 and ASTM F 877 tested as a system with manufacturer’s PEX tubing

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

1. Underground riser, welded 304 stainless steel one-piece riser assembly with flanged end and tie-rod bracket, UL and FM approved, AMES In-Building Riser Model “IBR2 Series” for 3” and smaller or “IBR Series” for 4” and Larger
2. 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.

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

1. 3 Inch and Smaller:

a. Piping: Polyvinyl Chloride (PVC) pipe; ASTM D1784 and ASTM D1785 or ASTM 2241. NSF stamped and approved for potable water system and rated for 200 psi minimum pressure.
b. Fittings: Schedule 40 PVC ASTM D2466 NFS stamped and approved for potable water system. Fittings shall be rated for 250 psi working pressure.

E. Unions:

1. 3 Inch and Smaller: ANSI B16.22 wrought copper; solder end fittings.
2. Provide dielectric isolating unions, brass to brass, at all junctions or connections between metallic piping of dissimilar metal. Acceptable Product: Watts LF3008.

F. Valves and Supports:

1. Provide lead-free bronze full-port ball valves with stainless steel trim for pipe sizes 3" and smaller. Provide flanged lead-free bronze or epoxy coated full port valves with stainless steel trim from pipe sizes 3” or larger. Butterfly valve are not allowed. Refer to Section 22 05 00 and 22 21 13, Basic Materials and Methods.
2. Shut-off valves located above ceiling shall be installed no greater than 24” above ceiling. Contractor shall offset piping as required in order to meet this installation requirement. Valve stems shall be set parallel to the finished floor.
3. Insulation at valves shall be chamfered or valve handle extensions shall be provided to avoid damaging the pipe insulation.

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. Wilkins.
c. Apollo.

2. Atmospheric, check valve type.
3. Bronze body construction with polished chrome finish.

E. Spill -Resistant Vacuum Breakers:

1. Acceptable manufacturer:

a. Watts.
b. Wilkins.
c. Apollo.

2. Anti-Siphon
3. Testable, check valve type.
4. Lead Free Bronze body construction with polished chrome finish.
5. Equal to Watts LF008PCQT

F. Reduced Pressure Type Backflow Preventer Assembly:

1. Acceptable manufacturers:

a. Watts.
b. Wilkins
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. Bronze body construction up to 2-1/2 Inches.
5. Cast iron body construction 3 Inches and over with stainless steel internal ports and FDA approved fused epoxy coating.
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. LF909S (FDA)-QT or LF009S-QT.

G. Double Check Backflow Preventer Assembly:

1. Acceptable manufacturers:

a. Watts.
b. Wilkins
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. 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. LF709S (FDA)-QT or LF007S-QT.

H. HB-1: Hose Bibbs Within Mechanical Rooms or Unfinished Building Space: 3/4" chrome plated brass compressed cocks; hose connection; wheel handle, lock shield, vacuum breaker; Woodford B24, or equivalent by T&S Brass or Josam.

I. HB-2: Hot and Cold Wall Hydrants: Bronze hydrant with rough brass box, bronze casing and "T" handle key with locking cover, 3/4 inch vacuum breaker with "water" cast on cover. Twin-Temp Hydrant shall be Jay R Smith 5560QT-CL-NB, 3/4 inch inlets, or approved equal by Josam or Wade. Hydrant shall be installed a maximum of 30” above finished grade, unless noted otherwise

J. HB-3, Quick Connect Water Connection – Provide a ¾" lead-free stainless steel quick-disconnect hose coupling with plug and socket with ball-bearing sleeve locking mechanism and Buna-N Rubber washers with screen. Shall be equal to Gorilla Easy Connect model QCLSS-1.

K. NFWH-1: Non-Freeze Wall Hydrants - Exposed Non-Freeze Wall Hydrant with Integral Vacuum Breaker: Woodford B65 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. Equal by Jay R Smith.

L. HDN-1, Hog Fill: Edstrom - single sided Hog Trigger Nipple, 1.5 qrts./min stainless steel watering device with 200-mesh filter, o-ring seal, with AquaChief #8160191500, 304 stainless steel, 16 ga. body, 50" stainless steel square water pipe, angled trough watering bowl, with galvanized steel mounting brackets #8150781501.

M. Medicated Dosing – Dosatron "D25RE2", 11 gpm dosing pump, water driven motor. Provide with ¾" stainless steel reduced pressure backflow preventer, isolation valves, 200 mesh in-line filter, check valve, union, dosing pump, union, and isolation valve. Provide with normally closed by-pass around dosing pump.

N. Trap Primer:

1. Automatic Trap Primer shall be designed to deliver potable water to floor drains. The trap primer shall be 120V solenoid operated with a 24 hour timer for solenoid operation. 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. Trap
2. TP-1: Trap primers serving floor drains/floor sinks in all spaces shall be solenoid operated, with proper distribution unit where required. Precision Plumbing Products, Inc., Smart Primer SMP-500, Mini-Prime Electronic Trap Primer Model MP-500 (115V/24V/220V) or Prime-Time Electronic Trap Primer Model PTS Series (dependent on the quantity of connections 4-12). Coordinate electrical connection to solenoid.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall provide map of all zone valves (floors, wings, sections, future additions, etc..) locations as part of the close-out documents. One (1) shall be printed and located in the main Mechanical Room. This maps shall be installed in an aluminum frame with a Lexan cover.

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

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

D. 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.

E. 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.

F. 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.

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

H. 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.

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

J. Isolation Valves:

1. Walk-In Chases Restroom (Where Provided) – Provide an individual shut-off valve to each side of the chase, as close as possible, to the chase opening. No piping shall cross the chase below 7'-6".
2. Gang Restroom without a Walk-In chase – In the chase behind an access panel, shall be a minimum 18"x18" access panel. One valve may turn off the entire restroom. Locate the main shut-off valve and access panel on the wide side of the Men's ADA stall.
3. Individual (private) restrooms - In the chase behind an access panel, shall be a minimum 18"x18" access panel.
4. Individual fixtures – Shall be located above the ceiling within 24"of the fixture water risers.
5. Isolation valves located above ceilings shall be set no higher than 24" above the ceiling. The water piping shall offset as required to meet this mounting requirement. Valve stems shall be set parallel to the finished floor. Insulation at valves shall be chamfered or valve handle extensions shall be provided to avoid damaging the pipe insulation.
6. Kitchen Equipment – Each piece of kitchen equipment supplied with water shall have isolation valves located above the ceiling within 24" of the water risers where the ceiling is accessible. Provide access door and frame where ceiling is not accessible.
7. Isolation valves on the domestic hot and cold water system shall be provided in corridors to allow for the isolation of building zones (wings, sections, and areas of the building). Avoid the use of wall access to valves and other plumbing devices. Where possible, locate valves and other devices above lay-in ceiling.
8. Isolation valves on the domestic cold and hot water system shall be provided to isolate classrooms and showers. Valves shall be located in the corridor where possible.
9. Isolation valves shall be provided to isolate male and female locker rooms separately.
10. Isolation valves on the domestic cold and hot water system shall be provided at individual sinks/fixtures at the supply risers above the ceiling.
11. Isolation valves for non-freeze wall hydrants shall be located within 24" of riser drop to non-freeze hydrant.
12. Isolation valves for roof hydrant or other equipment that is mounted high in the structure shall be set no higher than 24" above the ceiling.
13. Insulation at valves shall be chamfered or valve handle extensions shall be provided to avoid damaging the pipe insulation.
14. Zone Valve Map: A map of the zone valves (floors, wings, sections, future additions, etc.) shall be provided to the owner at the completion of the project. Provide one (1) copy of this valve map in the Main Mechanical Room. The map shall be installed in an aluminum frame and Lexan cover.
15. A valve tag chart shall be located immediately adjacent to the plumbing Zone Valve Map located in the Main Mechanical Room. This chart shall be installed in an aluminum frame and Lexan cover.

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

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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.

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

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 Fuel 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 new 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, butt 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.

F. All gas piping installed in sleeves shall have welded joints, regardless of size.

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 GAS PIPING BELOW SLAB OR IN CRAWLSPACE

A. Below Slab Underground:

1. Pipe: Sleeved jacketed corrugated stainless steel tubing with polyethylene sleeve.
2. Fittings: No fittings allowed below slab or grade.
3. All gas piping below slab or grade shall be routed in ventilated sleeve to exterior roof and terminated with 12" gooseneck and bug screen.

2.5 VALVES

A. Acceptable Manufacturers:

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

B. Valves: 125 LB iron cocks, square 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.

2.6 GAS PRESSURE REGULATORS

A. Acceptable Manufacturers:

1. Equimeter.
2. Fisher.
3. Sensus.
4. Itron

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 bugproof 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. Regulators shall be installed upright and per the manufacturer's installation instructions.

H. Contractor shall provide the spring color and orifice size as required to meet the required downstream pressure and flow.

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

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

2.7 ROOF GAS PIPE SUPPORTS

A. Pipe supports shall have stainless steel adjustable height hard cast rubber roller w/ nylon bushing pipe supports for all roof top utility lines. Refer to manufacturer's recommendations for spacing and appropriate pipe support size of pipe. provide, as a minimum supports as follows:

1. Within 3’-0” of all equipment connections
2. Within 2’-0” of each change in direction, elbow & tee.
3. Not more than every 10’-0” on centers beyond those indicated above.

B. Provide Mapa model MS-5RA or equal by Erico or Miro

C. Provide with Traffic Pad, Mapa model WP1016.

2.8 VENT CAPS

A. Caps shall be weatherproof with bugproof 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.

2.9 GAS PIPE SLEEVES

A. 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.

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. Piping exposed on the exterior wall of the building shall be coated with red primer and a minimum of two coats of paint to match building wall surface, contractor shall coordinate the exact color with the architect. Piping exposed on the roof of the building shall be coated with red primer and a minimum of two coats of “Safety Yellow” paint. Preparation of piping and painting shall comply with other applicable sections in Division I.

D. 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.

E. Valves:

1. Unions and Valves shall be provided at each piece of equipment. Valves shall be located immediately upstream of the equipment dirt (drip) leg.
2. Valves shall be located on the gas main piping on roof at major branch lines or legs to allow for isolation of areas, wings, sections, and future additions.

F. 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.

G. 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.

H. 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.

I. 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.

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

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

L. 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.

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

N. 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.

C. Unless otherwise noted for specific products, all material shall be manufactured in the United States and/or shall comply with the most current “Buy America” Act formally known as the North America Free Trade Agreement, NAFTA.

1. Floor Drain manufacturers do not need to comply with the most current “Buy America” Act.
2. Floor Sink manufacturers do not need to comply with the most current “Buy America” Act.
3. Trench Drain manufacturers do not need to comply with the most current “Buy America” Act.
4. Clean-Out manufacturers do not need to comply with the most current “Buy America” Act.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Above & Below Slab: Schedule 40 PVC

1. Pipe 1-1/2 - 6 inches: Poly Vinyl Chloride (PVC) schedule 40, drain waste vent (DWV) pipe, ASTM D26654 and ASTM 1785, NSF stamped and approved. System shall be rated for 200 psi minimum pressure.
2. Fittings 1-1/2 - 6 inches: Poly Vinyl Chloride (PVC) schedule 40, DWV patterned fitting, 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.
4. Anywhere non-plenum rated pipe is installed in return air plenums, all exposed portions of this pipe shall be covered with a plenum safe jacketing, or wrap, system per insulation Specification 22 07 00 or use cast iron piping as specified above.
5. 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.

    a. Pipe and fittings above grade, all sizes: ASTM A74 service weight, cast iron, no hub.
    b. Joints, all sizes: No hub coupling “clamp all Hi-Torq 80, Husky SD-2000, Ideal HD-Yellow.
    c. Pipe and fittings below grade, all sizes: ASTM A74 service weight, cast iron, single hub with hub and spigot fittings.
    d. All cast iron roil pipe and fittings shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI) and be NSF Internationally listed, by Tyler Pipe, Charlotte Pipe or AB&I.

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. Contractor shall provide a map of all clean-out locations. This map shall be posted in the Custodial Closets and Mechanical Rooms.

E. Cleanout Plugs:

1. Meet requirements of Plumbing Code, with American Standard pipe threads.
2. Taper thread bronze raised head plug.

F. Wall cleanouts shall be provided at each fixture and/or non-walk-in chase toilets as follows:

    1. End of Line Clean-outs set 12” above flood line of the water closets.

2. At Urinals – provide sweeping wye off vent a minimum of 2” above fixture flood rim to the side of the fixture.
3. At lavatories – provide sweeping wye off vent 2” above fixture flood rim. Coord. with EMSISD project manager and Architect for lavatory spacing to allow for clean-out above flood rim.
4. Provide main stack clean-out (where sewer line drops below the floor), this shall be set 12” above flood rim of lowest water closet. Where a vertical carrier is utilized for the main stack drop, provide a clean-out 12” above the flood rim of the water closet on a 4” vent stack.
5. Cleanouts should face into the restroom from the fixture being served. If back-to-back fixture is served, provide towards Boys/Mens RR.

G. Cleanouts shall be provided at each walk-in chase toilets as follows:

1. For each side of the walk-in chase, provide an End of Line Clean-outs set 12” above flood line of the water closets. The system design, where possible, shall provide this end of line clean-out as close as possible to the walk-in chase door. This clean-out shall face into the chase walkway.
2. At Water Closets – provide sweeping wye off vent a minimum of 12” above the flood rim of the fixture. This clean-out shall face towards the chase door.
3. At Urinals – provide sweeping wye off vent a minimum of 2” above fixture flood rim. This clean-out shall face towards the chase door.
4. At lavatories – provide sweeping wye off vent 2” above fixture flood rim. This clean-out shall face towards the chase door.
5. Provide main stack clean-out (where sewer line drops below the floor), this shall be set 12” above flood rim of lowest water closet. Where a vertical carrier is utilized for the main stack drop, provide a clean-out 12” above the flood rim of the water closet on a 4” vent stack.
6. Cleanouts shall towards the chase door to allow for easy access.

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

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

J. 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.

K. Acceptable Products:

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

   a. Round Nickel Bronze top.
   b. Scoriated top.
   c. Raised Head Taper Threaded Bronze Plug Smith 4475.
   d. Smith No. 4053L-NB-U.

2. In floor with ceramic tile finish:

   a. Square Nickel Bronze top.
   b. Scoriated top.
   c. Raised Head Taper Threaded Bronze Plug Smith 4475.
   d. 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. Raised Head Taper Threaded Bronze Plug Smith 4475.
   d. Smith No. 4532Y-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. Raised Head Taper Threaded Bronze Plug Smith 4475
d. 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. Raised Head Taper Threaded Bronze Plug Smith 4475.
d. 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. Raised Head Taper Threaded Bronze Plug Smith 4475.
d. Smith No. 4053L-NB-U.

7. Exposed Stack:

a. Duco Coated Cast iron cleanout "tee".
b. Raised Head Taper Threaded Bronze Plug Smith 4475.
c. Smith No. 4513S-Y-U.

8. 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 Raised Head Taper Threaded Bronze Plug Smith 4475.
e. Smith No. 4263L-U.

9. 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. Raised Head Taper Threaded Bronze Plug Smith 4475.
d. Smith No. 4233L-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. For
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 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.
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.

F. Provide deep seal cast iron traps with trap primer connections for all floor drains and hub drains that are served by T.P. lines routed below the slab or floor and cannot connect to T.P. connection on drain body.

G. Commercial Laundry Galvanized Roof Drain

1. Galvanized coated cast iron body with internal galvanized parts. Combined clamping and gravel stop; galvanized cast iron mushroom dome drain receiver, no hub outlet; flashing collar with underdeck clamp, adjustable collar, support ring, and vandalproof dome
2. Provide two stainless steel lint screens with aluminum c-channel slots for lint screens at the drain location.
3. Drains from extractors shall be piped to the end of the trench opposite the drain inlet to allow for suds dissipation.
4. Acceptable Product: Josam 22010-20

H. TD-1, Trench Drain:

1. Provide a 10” wide precast polymer concrete interlocking channel of tongue and groove channel with integral metal rail and plastic dome strainer.
2. Channel shall have interlocking ribs for locking channel into floor slab.
3. Channel grate: Heavy duty longitudinal stainless steel slot bar; secured by built-in locking system.
4. Jay R Smith, 9898 with 9880-630-SSM grate.

I. CB-1, Catch Basin:

1. Provide 28”x37”x28” solids interceptor, unit shall have a lifetime warranty. Interceptor shall be constructed of polyethylene. Interceptor liquid holding capacity shall be 57 gallons and solids capacity shall be 25 gallons. Provide H20 rated ductile grate with flange.
2. Striem CB-50 - (24” H20 Ductile Iron ADS Nyloplast grate).

J. CB-2, Catch Basin:

1. Provide 28”x37”x28” solids interceptor, unit shall have a lifetime warranty. Interceptor shall be constructed of polyethylene. Interceptor liquid holding capacity shall be 57 gallons and solids capacity shall be 25 gallons. Provide H20 rated cover with flange.
2. Striem CB-50-S-C24-HP.

K. AAV, Air Admittance Valve:

1. Shall conform to ASSE 1049/1050/1051, NSF 14 and shall have ASSE approved.
2. Material shall match installation application,
3. Acceptable Manufacture: Studor, Inc.

2.4 EQUIPMENT

A. SWB-1, Sample Basin:

1. Provide a sample basin on the building outlet of the animal waste connections. Basin shall have a lifetime warranty, seamless, molded polyethylene with a minimum 7/16" uniform all thickness. Provide basin extension as required for cover to be flush with final finished grade, field cut risers Schier #FCR10
2. Acceptable product:

    a. Schier SV10

2.5 VENT PIPE ROOF PENETRATION FLASHING

A. ALL VENT THROUGH ROOF LOCATIONS SHALL PASS THROUGH THE WEST SIDE OF THE PITCHED METAL ROOF PEAK ON BOTH BUILDINGS.

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

C. 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.

D. 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.

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

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. Long sweeping wyes shall be utilized at all sanitary sewer connections.

B. Slope:

1. Slope horizontal drainage lines 2 inches and smaller 1/4 In per foot toward main sewer.
2. Slope 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. Contractor shall provide map of all clean-out locations as part of the close-out documents. One (1) shall be printed and located in the main Mechanical Room and one (1) shall be printed and located in the main Custodial Room. These maps shall be installed in an aluminum frame with a Lexan cover.
2. 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.
3. Cleanouts shall be readily accessible.
4. Contractor shall not install floor clean-outs in corridors or grade clean-outs walkways.
5. 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.
6. Space floor cleanouts not more than 50 feet apart.
7. If local requirements are more stringent than those indicated herein then those shall govern.
8. Cleanouts located at restroom batteries and/or at water closets shall be installed 12 inches above the flood rim of the water closet.
9. Contractor shall provide wall cleanout at the following location with a sweeping wye fitting on the vent side of each fixture:

    a. Urinals, shall be set to the side of the fixture, off the vent piping, a minimum of 6” above the flood rim of the fixture.
    b. Water Closets, shall be set to the side of the fixture, off the vent piping, a minimum of 12” above the flood rim of the fixture.
    c. Lavatories, shall be set to the side of the fixture a minimum of 2” above the flood rim of the fixture.

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 the entire sanitary sewer system for the facility shall be tested as indicated below. Eagle Mountain 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.

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.

C. Provide a subsoil drainage system as indicated herein and as indicated on the Contract 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.

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.

C. Unless otherwise noted for specific products, all material shall be manufactured in the United States and/or shall comply with the most current “Buy America” Act formally known as the North America Free Trade Agreement, NAFTA.

1. Clean-Out manufacturers do not need to comply with the most current “Buy America” Act.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Schedule 40 PVC Piping Above & Below Grade:

1. Pipe 1-1/2 - 16 inches: Poly Vinyl Chloride (PVC) schedule 40, drain waste vent (DWV) pipe, ASTM D2665 and ASTM 1785, NSF stamped and approved. System shall be rated for 200 psi minimum pressure.
2. Fittings 1-1/2 - 16 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 manufacturers 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.
4. Anywhere non-plenum rated pipe is installed in return air plenums, all exposed portions of this pipe shall be covered with a plenum safe jacketing, or wrap, system per Insulation Specification 22 07 00 or use cast iron piping as specified in 22 1316.

2.2 DOWNSPOUT BOOTS

A. Downspout boots for connection to underground storm system shall be constructed of factory applied epoxy coated cast iron, cast aluminum or 304 stainless steel, 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

2.3 CLEANOUTS

A. Acceptable Manufacturers:

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

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. Tapered raised head 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. Raised Head Taper Threaded Bronze Plug Smith 4475.
    d. Smith No. 4053L-NB-U.
2. In floor with ceramic tile finish:
    a. Square Nickel Bronze top.
    b. Scoriated top.
    c. Raised Head Taper Threaded Bronze Plug Smith 4475.
    d. 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. Raised Head Taper Threaded Bronze Plug Smith 4475.
    d. Smith No. 4532Y-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. Raised Head Taper Threaded Bronze Plug Smith 4475.
    d. 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 and screwed Stainless Steel Carpet Cleanout Marker. (-Y).
    c. Raised Head Taper Threaded Bronze Plug Smith 4475.
    d. 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. Raised Head Taper Threaded Bronze Plug Smith 4475.
    d. Smith No. 40513-NB-U.
7. Exposed stack:
    a. Duco Coated Cast iron cleanout "tee".
    b. Raised Head Taper Threaded Bronze Plug Smith 4475.
    c. Smith No. 4513S-Y-U.
8. Underfloor chase:
    a. Cast iron Cleanout body.
    b. Raised Head Taper Threaded Bronze Plug Smith 4475.
    c. Smith No. 4293L-U.
9. Vehicle Traffic Outside Grade:
    a. Duco Coated Heavy Duty Cast Iron Round Cleanout Housing.
    b. Scoriated Cast Iron Cover with Lifting Device.
    c. Vandalproof screws
    d. Cast iron cleanout ferrule and Raised Head Taper Threaded Bronze Plug Smith 4475.

e. Smith No. 4263L-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. Raised Head Taper Threaded Bronze Plug Smith 4475.
d. 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 larger than 3 Inches: 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: At the completion of project where new sanitary sewer piping is installed the entire sanitary sewer system for the facility shall be tested as indicated below. Eagle Mountain 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.

END OF SECTION

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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.

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.

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

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 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. 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.

K. 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.

L. 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.

M. Bronze Lead-Free Ball valves: 2-1/2” 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 shall be full port design with stainless steel ball and stem.
3. All ball valves shall be manufactured from a dezincification resistant material with less than 15% zinc.
4. Provide extended lever handles for all valves installed in insulated lines where insulation is not chamfered as detailed in the documents.
5. Only where pressure fitting and valve are owner approved: Valves 2” and smaller shall be bronze ball valves with stainless steel ball and steam, only Viega press valves shall be utilized. Viega 2971.3ZL

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

1. Ball valves shall be on the following products:
   a. Watts G4000M1.
   b. Apollo 6PLF.
   c. Nibco T-585-66-LF or S-585-66-LF.
   d. Apollo 77CLF-140 Series.
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.

O. 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.

P. 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-650-02 Series.

Q. 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. 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.

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. 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.

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.

2.6 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 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 water pump.
2. At the inlet and outlet of each water coil.
3. At the inlet and outlet of each heat exchanger, evaporator, and condenser.
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, evaporator, and condenser.
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, 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. 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 22 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 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 UNDERGROUND PIPING PROTECTION

A. Protect the entire surface of all underground steel piping against rust and corrosion.

B. For piping and nuts and bolts, such as those on mechanical joint piping systems, not specified elsewhere 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.

3.7 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.

3.8 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.

3.9 ISOLATION VALVES:

A. Isolation valves as described above shall be located as follows:

1. Walk-In Chases Restroom (Where Provided) – Provide an individual shut-off valve to each side of the chase, as close as possible, to the chase opening. No piping shall cross the chase below 7’-6”.
2. Gang Restroom without a Walk-In chase – In the chase behind an access panel, shall be a minimum 18”x18” access panel. One valve may turn off the entire restroom. Locate the main shut-off valve and access panel on the wide side of the Men’s ADA stall.
3. Individual (private) restrooms - In the chase behind an access panel, shall be a minimum 18”x18” access panel.
4. Individual fixtures – Shall be located above the ceiling within 24”of the fixture water risers.
5. Isolation valves located above ceilings shall be set no higher than 24” above the ceiling. The water piping shall offset as required to meet this mounting requirement. Valve stems shall be set parallel to the finished floor. Insulation at valves shall be chamfered or valve handle extensions shall be provided to avoid damaging the pipe insulation.

6. Kitchen Equipment – Each piece of kitchen equipment supplied with water shall have isolation valves located above the ceiling within 24" of the water risers where the ceiling is accessible. Provide access door and frame where ceiling is not accessible.
7. Isolation valves on the domestic hot and cold water system shall be provided in corridors to allow for the isolation of building zones (wings, sections, and areas of the building). Avoid the use of wall access to valves and other plumbing devices. Where possible, locate valves and other devices above lay-in ceiling.
8. Isolation valves on the domestic cold and hot water system shall be provided to isolate classrooms and showers. Valves shall be located in the corridor where possible.
9. Isolation valves shall be provided to isolate male and female locker rooms separately.
10. Isolation valves on the domestic cold and hot water system shall be provided at individual sinks/fixtures at the supply risers above the ceiling.
11. Isolation valves for non-freeze wall hydrants shall be located within 24” of riser drop to non-freeze hydrant.
12. Isolation valves for roof hydrant or other equipment that is mounted high in the structure shall be set no higher than 24” above the ceiling.

3.10 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 22 05 00.

3.11 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. Condensing Gas Fired Commercial Water Heater, Storage Type.
2. Thermal Expansion Tanks.
3. Circulating Pumps, Aquastat and programmable timer.
4. Thermostatic Mixing Valves.

PART 2 - PRODUCTS

2.1 CONDERNSING POWERED GAS FIRED COMMERCIAL WATER HEATERS, STORAGE TYPE

A. Furnish and install a condensing, automatic storage type water heater with a submerged combustion fire tube as indicated and located on the drawings and of capacities, characteristics, sizes, etc., as scheduled on the drawings. Heater shall meet or exceed the current ASHRAE 90 Minimum Performance of Water Heating Equipment, effective January 1, 1994.

B. Water heater shall comply with the Low Nox regulations of TECQ (formerly TNRCC).

C. Water heater shall be a category IV, condensing appliance. It will be UL listed for use with pressurized, with material as approved by the water heater manufacturer up to inline draft inducers as required. Refer to Div. 23 for additional requirements.

D. The heater shall utilize a completely submerged fire tube heat exchanger. For corrosion protection, all wetted surfaces will be of non-ferrous materials or alloys.

E. Combustion shall be provided by a forced-draft power burner. The burner shall have a leak-free, fan housing for quiet operation, and shall be U.L. Listed. The gas burner shall meet the specifications required by U.L. Provide inline draft inducer where the horizontal flue pipe exceeds 25% of the total flue distance. Furnish draft inducers where required to assure proper operation of the heating equipment.

F. Gas water heaters shall be A.G.A. or U.L. approved for natural gas and approved to operate at 140 Deg.F., and rated for 150 PSI working pressure.

G. Tank Liners:

1. Tank shall be a stainless steel alloy furnished with a magnesium anode for corrosion protection.
2. Or, tank shall be glass lined internally with alkaline borosilicate composite fused to steel by heating to 1600 Deg.F. and furnished with a magnesium anode for corrosion protection

H. The water heaters shall be manufactured by a company that has achieved certification to the ISO 9001 International Quality System, which requires regular external auditing of all order entry, engineering design, and product manufacturing processes. The heater shall satisfy current Federal Energy Policy Act (EPACT) standards for both thermal efficiency and standby heat losses as established for gas-fired water heaters incorporating storage tanks.

I. Heater shall have adjustable thermostat, high-limit thermostat, pressure regulator, spark ignition with interrupted pilot and factory set to burn natural gas. The heater shall be U.L. or AGA labeled, constructed with Section IV of the ASME Code. Tank shall be National Board Registered and stamped for 150 PSI operating pressure. Provide A.G.A. rated pressure and temperature relief valves. The P&T valves shall be set for 205 Deg.F. and 150 pounds pressure and shall be of the self-closing type. Install the relief valves so that the bulbs will be immersed in the tanks. Pipe relief valve outlets full size to the nearest floor drain, or outside per requirements of local authorities.

J. CONDENSATE

1. Low-profile condensate neutralizing tubes. Tubes shall be refillable;
2. Condensate traps, manufactured from only non-corrosive materials.
3. Provide neutralization kit for each bank of heaters.
4. Direct Vent: The water heater(s) shall meet safety standards for direct vent equipment as noted by the International Mechanical Code, Sections 703.3 and 1106.6; and ASHRAE 15-1994, Section 8.13.6

K. CO (Carbon Monoxide) Monitor & Interlock: Contractor shall provide CO monitor in boiler/water heater room where gas fired boiler/water heaters, where the total gas input of equipment exceeds 200,000 BTUH, are located. Shall be equal to AGS Mini-Merlin CO & Interlock Monitoring System.

L. Contractor shall provide a gas train pressure regulator as required in order to meet the minimum gas pressure needed for all the heaters to fire at the same time.

M. Contractor shall provide a boiler start-up report. This shall be included in the O & M Close-Out Documents.

N. Heater Shall be supply from the manufacturer with a minimum 15 year warranty.

O. Provide an aluminum alloy drain pan for each storage type water heater, where required by code. Pan shall be a minimum 0.025 inches thick, a minimum of 1.5 inches tall and provided with a pan drain of not less than 0.75 inches. Drain from pan shall be CPVC and shall terminate open sight at nearest floor drain. Acceptable product: Holdrite “Quick Pan”, QP-C Series up through 30” diameter tanks.

P. Acceptable manufactures:

1. A.O. Smith
2. Lochinvar

2.2 CARBON MONOXIDE MONITOR & INTERLOCK:

A. Contractor shall provide CO monitor in boiler/water heater room where gas fired boiler/water heaters, where the total gas input of equipment exceeds 200,000 BTUH, are located. Shall be equal to AGS Mini-Merlin CO & Interlock Monitoring System.

B. The carbon monoxide detector and water heater/boiler shall be interlocked to disable the burners when the measured level of CO rises above 50 ppm.

C. The carbon monoxide detector shall disable the burners upon loss of power to the detector when there are dry contacts available on the boiler control panel for this application. When these contacts are not available provide a master gas normally closed solenoid valve on the gas main supply to the boilers. The CO detector shall disable the solenoid valve. Solenoid valve shall be equal to ASCO “Red Hat” 215 Series aluminum body solenoid valve.

D. The carbon monoxide detector shall be calibrated in accordance with the manufacturer’s recommendations or every eighteen months after installation of the detector. A record of calibration shall be posted at or near the boiler/water heater, or be readily accessible to an inspector.

2.3 THERMAL 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 for domestic water heating systems for storage less than 119 gallons, BTUH input less than 199,000 or KW input less than 54 KW (Non-ASME):

1. Bell and Gossett "PT" series.
2. Watts "DET" Series.
3. Amtrol “Therm-X-Trol”, or approved equals only

G. Acceptable manufacturers for domestic water heating systems for storage greater than 119 gallons, BTUH input greater than 199,000 or KW input greater than 54 KW (ASME):

1. Bell and Gossett "PTA" series.
2. Watts "DETA" Series.
3. Amtrol “Therm-X-Trol”, or approved equals only

2.4 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 with bronze impeller and bronze 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

2.5 THERMOSTAT MIXING VALVE (Refer to Schedule for Valve)

A. RADA 320-R or Leonard XL-32A-LF-DT-RF-RL, 3/4" inlet, 3/4" 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 assembled and tested unit mounted exposed on wall. Mixing valve assembly shall be piped per manufacturer's recommendations. Coordinate with Architect for exact location. Acceptable manufacturer: Armstrong Intl., RADA or Leonard.

B. Leonard Model 270-LF, thermostatic point of use mixing valve shall be allowed fo r 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.

2.6 FLUE PIPING

A. Refer to the manufacturer and Div. 23 for flue piping requirement.

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. Install a union, dirt leg, and gas shut-off cock at each water heater.

C. Adjust gas pressure regulator at heaters for proper firing capabilities.

D. Install flues as supplied and recommended by the water heater manufacturer.

E. Coordinate with other trades to provide equipment housekeeping pads as shown on the drawings and per Section 22 05 00.

F. 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.

G. 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 05 00.

H. Provide thermal expansion protection for all heating equipment as specified and required by heating equipment manufacturer's written warranty.

I. 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.

J. 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.

K. 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.

L. 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.

M. Furnish and install relief valves on cold water inlet piping for all bottom feed water heaters. Valve shall comply with ANSI Z21.22.

N. Refer to Division 23 00 00 for sheet metal and flue piping requirements. In line draft induces shall be provided as part of the flue piping system. Size and capacity of in line induces shall be based on actual equipment installed and field conditions.

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.

B. Unless otherwise noted for specific products, all material shall be manufactured in the United States and/or shall comply with the most current “Buy America” Act formally known as the North America Free Trade Agreement, NAFTA”.

1. Plumbing Fixture Carrier manufacturers do not need to comply with the most current “Buy America” Act.

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

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.

A. Standard Plumbing Fixtures:

1. American Standard.
2. Kohler.
3. Sloan.
4. Zurn
5. Elkay.
6. Just.
7. Bradley.
8. Acorn.

B. Carriers:

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

C. Seats:

1. Church.
2. Beneke.
3. Olsonite.
4. Centoco.

D. Faucets:

1. Chicago.
2. T&S Brass.
3. American Standard

E. Flush Valves:

1. Sloan, Sloan
2. Zurn, AquaVantage

F. Stop Valve in Hot and Cold Supply Lines to Each Fixture:

1. Chicago.
2. McGuire.
3. T&S Brass.
4. Engineered Brass Company.

G. Stainless Steel Sinks:

1. Elkay.
2. Just.
3. Metcraft.

H. Service Sinks:

1. Fiat
2. Stern Williams.
3. American Standard.
4. Haws.

I. Electric Water Coolers:

1. Halsey-Taylor.
2. Elkay
3. Oasis

a. Units shall be all stainless steel.
b. Units shall be mechanical push operation. No electronic actuation.
c. Units shall not be wired to building EMS.
d. After construction is complete contractor shall clean air cooled condenser coils prior to turning building over to EMS-ISD.
e. No filters.
f. Provide a keyed switch to turn off the EWC for maintenance. They do not want to do this at a breaker.
g. Reset button for the GFCI circuit shall not be behind the EWC.

2.2 MATERIALS

A. Fittings: Chrome plated heavy cast brass.

B. Nipples: Extra heavy.

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 flexible stainless steel braided, 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 and 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, equipment 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. Sloan ST-2009, floor mounted, siphon jet, elongated bowl, 1.28 GPF, vitreous china with 1-1/2 inch top spud.
2. Flush Valve: Sloan "Sloan" 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.

WC-2- WATER CLOSET - FLOOR MOUNTED BOTTOM OUTLET - FLUSH VALVE - HANDICAP:
1. Sloan ST-2029, floor mounted, siphon jet, elongated bowl, 1.6 GPF, vitreous china with 1-1/2 inch top spud.
2. Flush Valve: Sloan "Sloan" 111-1.6-YBYC, 1.6 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:
1. Sloan UT-1009, wall hung, siphon jet, 0.5 GPF vitreous china with 3/4" top spud, 14-1/2" elongated, flushing rim and 2" female outlet connection.
2. Flush valve: Sloan "Sloan" 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.

U-2 - URINAL - HANDICAP:
1. Same as Fixture Type "U-1" except mount for handicapped.
2. 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 - COLD AND TEMPERED - STUDENT/HANDICAP:
1. Sloan SS-3065, 20" x 18" vitreous china, "D" shaped bowl, self draining deck with side and back splash, modified to comply with ADA front approach requirements, 4" faucet centers, punched for concealed arms.
2. Faucet/Strainer: Chicago 420-T45E2805ABCP - ASSE 1070 compliant and cast brass valve body, 5" integral spout, 4" centers, vandal-resistant color coded chrome single lever, ceramic cartridge, ADA Compliant, vandalproof aerator with integral 0.5 GPM flow restrictor. Provide Chicago 327-XCP perforated grid drain and wheelchair offset tailpiece for ADA front approach access.
3. Supplies: McGuire stainless steel braided flexible riser supplies with lead-free quarter turn angle check 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 - WALL HUNG - ADA COMPLIANT WITH BOTTLE FILLER

1. Halsey-Taylor HTHB-HAC-8BLSS, 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. Cooler shall deliver 8.0 GPH of 50 Deg.F. water at 90 Deg.F. ambient and 80 Deg.F. inlet water. **Entire unit shall be all satin stainless steel finish**, upper basin, middle shroud, side panels and lower shroud. Furnish accessory apron when units are mounted on an exposed wall or necessary to provide the ADA mandatory underside clearance.
2. Support: Josam 17560-WCBLSeries Bi-Level floor mounted carrier with four (4) support plates, two (2) high and two (2) low.
3. Supplies: McGuire braided stainless steel supply risers with lead-free quarter turn 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.

S-1 - GENERAL PURPOSE SINK (FRONT APPROACH):

1. Elkay LRAD-1918, single compartment, Type 302, 18 gauge stainless steel, 16" x 11-1/2" x 6-1/2" deep, self-rimming, sound deadened underside, faucet deck, 3 hole punch, 3-1/2" drain opening, off-set front-to-back ADA Compliant.
2. Faucet: T & S Brass B-2856-WH4-CR, bottom mount, cast brass valve body, rigid copper, 8" centers, gooseneck rigid spout, quarter-turn ceramic cartridge, 4" wrist blade lever vandal-resistant color-coded chrome handles, ADA compliant, with vandalproof aerator.
3. Supplies: McGuire stainless steel braided flexible riser supplies with lead-free quarter turn angle check stops and chrome escutcheon plate with set screw.
4. 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.
5. 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.
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.

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: Chicago 897-RCJ KCP chrome plated, integral check stops, vacuum breaker, wall bracket pail hook, 3/4 inch hose thread, 8 inch center, arm handle and RCJ-KCP supply arm.
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.

WCB-1 - RESIDENTIAL WASHING MACHINE CONNECTION BOX:

1. Guy Gray Model MWB-2600-HA Series, 20 gauge steel box hot dipped galvanized, two inch (2") drain and 3/4" hose bibbs, with individual quarter turn ball valve and hammer arrestor.
2. Provide ¾” stainless steel braided hoses for connection to washer/extractor.

ICB-1 - ICEMAKER BOX CONNECTION:

1. Guy Gray Model SSMIB-6AB, 20 gauge stainless steel box, and ½" quarter turn angle valve with hammer arrestor.
2. Provide In-Line Water Filter System at all ice maker locations. Install behind refrigerators and in millwork, under the counter next to the ice maker for undercounter models. Filter System equal to Aqua Pure Refrigerator Ice Maker System.

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. Fixture Mounting Heights: Refer to Drawings.

F. Provide stop valve in each hot and cold water supply line to each fixture.

3.2 KITCHEN EQUIPMENT; 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.
3. Operation and Maintenance of all HVAC Equipment.

D. The Conditions of the Contract, including the General Conditions and Supplementary Conditions, and Division 01 - General Requirements, apply to work covered by this section.

E. Refer to Division 01 for Construction Progress Schedules.

1.2 RELATED DOCUMENTATION

A. See Division 01 specifications for the following.

1. Product Options
2. Product Delivery Requirements
3. Product Storage and Handling Requirements
4. Closeout Procedures
5. Operation and Maintenance Data
6. Warranties and Bonds
7. Project Record Documents
8. Spare Parts, Overages and Maintenance Materials

B. See other Division 23 specifications.

C. See Division 26 specifications for coordination and power connections to powered items.

D. See Division 28 specifications for coordination with life safety systems.

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/technicians 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 360 and 270, as applicable, and be capable of starting and running at ambient outdoor temperatures as high as 115°F while operating to meet the maximum load requirement.

D. Units with refrigerant shall be designed to conform to ASHRAE Standard 15, latest revision.

E. Units shall be U.L. Tested and Certified in accordance with ANSI Z21.47 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 complete factory run test where required in its specification section. Each of these units shall pass this run test and repair as necessary prior to being allowed to be shipped to the project site.

PART 2 - PRODUCTS

NOT USED FOR THIS SPECIFICATION SECTION

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.

B. Owner shall operate all systems in cooperation with Contractor for a period of at least five (5) working days prior to, or shortly after, Substantial Completion.

C. Arrange for services of qualified manufacturer's representatives to fully instruct Owner on specialized portions of installations, such as air handling units and auxiliaries; automatic temperature controls, and water treatment systems.

D. 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.

E. 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.

F. 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.

G. Include services to assist with testing, adjusting, and balancing (TAB) work for HVAC systems. Refer to the TAB specification section for further requirements and scope delineation.

H. Include services to assist with commissioning services. Refer to the commissioning specification section for further requirements and scope delineation.

I. As part of Closeout Documents, submit a complete record of instructions with the maintenance instructions and data book (Data, 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.

J. 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 CLEAN UP

A. Remove all debris, rubbish, and materials resulting from cutting, demolition, 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

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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/technicians 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 general requirements of work in Division 01.

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 ensure 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 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.

E. Refer to Division 01 for cutting and patching requirements.

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 Energy Code.
6. Local Building Code.

7. Local Fire Code.
8. Local Plumbing Code.
9. Local Mechanical Code.
10. ICC 500 Standard for the Design and Construction of Storm Shelters.

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 Record Drawings at Project Closeout. 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 and other Division 23 specifications for closeout procedure requirements.

1.8 RECORDS AND INSTRUCTIONS FOR OWNER

A. Accumulate during the job's progress the following sets (in triplicate if physical copies are compiled or one (1) digital set), in accordance with the provisions of Division 01 closeout procedures.

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; copies of rejected shop drawings are not to be provided / included.
4. Copies of product data submittals (material, products, and equipment). Copies of rejected submittals are not to be provided / included.
5. Operating instructions for heating and cooling and other mechanical systems. Operating instructions shall include recommended maintenance and seasonal change-over procedures.
6. Other data and drawings required during construction.
7. Repair parts lists of all major items and equipment including name, address, and telephone number of local supplier or agent.
8. Valve tag charts and diagrams specified elsewhere herein.
9. Record Drawings shall be provided in electronic/digital format as determined by Owner. Provide in PDF or other format as determined by the Owner.
10. Provide copies of all City Inspection Certificates of Approval.
11. 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 01 for Project Closeout 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

eight (8) copies of each shall be submitted if submitted in physical form. Additional copies will be required when indicated by the Architect and as required for project coordination. Electronic/digital submittals are permitted as well unless noted elsewhere for such items as samples.

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 products, material, and/or equipment 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 submitted data to ensure that it conforms to the requirements of the Drawings and specifications, and there are no errors, omissions, and/or duplications. This shall be done prior to submission of the data and shall be indicated with a stamp on the submitted data indicating that the Contractor has reviewed for conformance and found the data acceptable. The engineer will not review submittals without this stamp.

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. Failure to include such a certification will subject the submittal to immediate rejection.

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 Division 01 firestopping requirements and other details as provided by the Architect and Structural Engineer.

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 ensure 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

1. Products of the same functions, performance, and design will only be considered if in full accordance with the requirements of Division 01 product options requirements.
2. The products of other manufacturers will be acceptable; only if, in the opinion of the Architect and Engineer, the substitute product is of a quality as good or better than the product 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.
5. Due to the nature of industry business, if a listed manufacturer is acquired by another manufacturer or changes its name during the course of the submittal phase, please indicate this in the submitted data.

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 01, 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 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, horsepower 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 ensure 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 Division 01 product storage and handling 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 or improper storage, protection, or handling. 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. Equipment or material that is improperly protected and made unclean as a result shall be cleaned and inspected for proper operation prior to installation.

D. On site storage shall not be inside the building during construction progress nor outside on site exposed to the weather and site environment, but shall be in approved trailers or as specifically approved otherwise by the Architect. Equipment shall not be stored directly on grade (dirt, grass, concrete etc.). Storage of equipment and materials inside the building shall only be allowed when so allowed by the Architect or Owner.

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 Division 03 - 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 ensure 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. Refer to the geotechnical engineer’s report for existing soil conditions and backfill recommendations.

C. 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.

D. 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.

E. 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.

B. 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.

C. 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.

D. 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.

E. 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 Closeout documents.

F. The inside building Dew Point shall not exceed 55°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 01.

1.23 FINAL CONSTRUCTION REVIEW

A. Schedule

1. Upon completion of the work specified in Division 23, there shall be a final construction review of the completed mechanical systems installations.
2. 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/Engineer.

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 the 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

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SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

B. Comply with Division 23 Sections, as applicable.

C. 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 manufacturer 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 (fans and pumps) 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. Pumps
2. Fans
3. Air Handling Units
4. Rooftop 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 Division 01 and Section 23 05 00 for the appropriate specification section governing the equipment with the motor.

B. For this specification section, Section 23 05 13, the product data submittal shall include tabulated data for all the motors in the project, previously submitted with the appropriate specification section. The table submitted shall list the motors for each system of equipment to be installed. The tabular form shall be one table, listing motor data for each type of equipment submitted. The lack of this information will be grounds for rejection of the submittal.

C. Product Data submitted under other Divion 23 specification sections shall include:

1. System / Equipment Name/Type
2. Motor Manufacturer
3. Motor Type [Open Drip Proof, Totally Enclosed (Fan Cooled or Air Over)]
4. Model of Manufacturer
5. Motor Horsepower
6. Motor RPM
7. 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
8. 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
9. 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 01.

1.4 QUALITY ASSURANCE

A. Comply with all regulatory requirements in the 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 of Specifications.
3. Applicable provisions of standards of National Electric Code (NEC).

B. 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 sources available before submitting, ordering and installing any motor or related controls.

B. Motors shall conform to the standards of manufacturer 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.

1. Motors exposed to weather shall be the totally enclosed type suitable for installation in ambient conditions for exposure to the sun, heat, and rain.
2. 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 manufacturer and pumps shall have motors of the same manufacturer; 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°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. Greaseable 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 as follows.

1. Reliance
2. Baldor
3. General Electric
4. A.O. Smith
5. U.S. Motors
6. 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 the manufacturer and performance requirements 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.

1. Motors exposed to weather shall be the totally enclosed type suitable for installation in ambient conditions for exposure to the sun, heat, and rain.
2. 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. They shall be as manufactured by the following.

1. A. O. Smith (E Plus III)
2. Baldor (Super E)
3. Reliance (Duty Master XE)
4. General Electric (Energy Saver)
5. U.S. Motors Premium Efficiency NEMA Design B, induction type rated for constant duty with 40°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, 460V, 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

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. Each variable torque motor served by a variable frequency drive shall be capable of operating over a 10:1 speed range.

J. 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

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SECTION 23 05 14

COMMON MOTOR STARTER REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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 (see the following for the form to follow).

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. Motor Starter Submittal Form:

MOTOR STARTER SUBMITTAL FORM

Item Number	Equipment Tag	Type of Starter	Enclosure Type	Brand / Model	Line Voltage	Phase	Control Voltage	Horsepower	Motor F.L.A.	Overload Heater Rating (Range of Amps)	Pilot Controls	Pilot Lights	Auxiliary Contacts	
													#N.O.	#N.C.
Other Notes:														
This form shall be completed for each individual motor starter to be furnished, as specified, and included as a part of the starter submittal.														

E. Provide Closeout Documents as required in Division 01.

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 in VAV terminal units 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.

1. 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.
2. Where used, the secondary side of the control transformer shall be grounded and the other side shall be fused.
3. Where starters are interlocked, the starter holding coils shall be of one voltage.
4. Where starter line voltages are different and above 120 volts to ground, provide control voltage transformers in the starters that are interlocked.

a. The control systems installer shall supply all electrical power supply and transformers as needed to serve control circuit requirements for temperature controls.
b. Control voltage in each starter shall be not more than 120 volts to ground, with an individual control transformer provided in each interlocked starter.
c. 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. Where two-speed motor starters are furnished, provide High-Low-Off-Automatic Switches and adjustable time interval decelerating relays.

J. Coordinate the purchase of all starting equipment, insofar as practical, such that all starting equipment on the project shall be of the same manufacturer.

K. Starters shall be a regularly manufactured product to meet the intent of all requirements specified herein.

L. Acceptable starters and controllers shall be manufactured by

1. Allen-Bradley.
2. General Electric.
3. Cutler-Hammer.
4. Square D.

M. Solid state type starters will be acceptable.

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 they are fully accessible and convenient for use. Where not specifically shown on drawings, 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 provided.

H. Field verify correct sizes of replaceable thermal overload elements for each motor actually provided. 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 01 - 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 and pumping systems as indicated on the drawings and/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 rating 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:

1. Submit shop drawings in accordance with Section 23 05 00.
2. Show VFDs on the shop drawings.

B. Product Data:

1. The submittal for this section 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.
2. In the submittal, clearly identify all options furnished including detailed wiring diagrams indicating required field connections and wiring to be provided under Division 26 and for Building Automation Control System interface.

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 equipment 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 3% rated input 3 phase A.C. line reactor combined with a 3% DC bus reactor, or a 50% rated A.C. input line reactor, without exception; D.C. bus reactors only are not a suitable substitute.

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. 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.

4. Shorting between terminals and all short circuiting.
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.

H. Variable frequency drives shall be the pulse width modulated (PWM) type as manufactured by the following.

1. ABB
2. Yaskawa
3. Danfoss
4. Others may be allowed if they are integral to main factory equipment.

I. 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 unless specifically indicated on the drawings.

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. 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.

C. 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

D. 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.

E. Provide a minimum of three (3) critical speed coast troughs for all fan drives.

F. Provide bus capacitors, or equivalent feature, for minimum 500 millisecond power loss ride - through capabilities at a minimum of 50% load.

G. Provide DC bus filter choke for maintaining high input power factor, minimum displacement angle of 0.95, over the entire range of operating speeds and loads.

H. Minimum drive efficiency shall be 95% at 50% speed and 97.5% at 100% speed conditions without exception.

I. 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.

J. 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.

K. The starting torque shall be 100% available from 0.5 Hertz up to 60 Hertz output operating frequency.

L. 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.

M. 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).

N. 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.

O. Provide power metering features to measure kWh consumption, kW demand, and power factor to be made available to the energy management system.

2.3 ELECTRONIC COMPONENTS QUALITY ASSURANCE

A. All electronic components or devices to include transistors, diodes, resistors, integrated circuits, capacitors, etc., shall be 100% inspected and load tested, including temperature cycling (0 Deg.C. to +65 Deg.C.) and ambient high temperature (+65 Deg.C.) load tested according to MIL-STD-8813B.

B. 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.

C. 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.

D. After all tests have been performed, each drive shall undergo a 24-hour burn-in test. The controllers shall be burned in at 100% inductive or motor load for 24 hours without an unscheduled shut down.

E. After the burn-in cycle is complete, each VFD shall be put through a 30-minute cycling motor load test before inspection and shipping.

F. Certification that all of the testing above has been performed shall be provided by the drive manufacturer.

G. Conduct in circuit testing of all printed circuit boards to ensure the proper mounting and the correct values for all electronic components.

H. Final printed circuit board assemblies shall be functionally tested. All tests and acceptance criteria shall be pre-programmed. All test results shall be stored as detailed quality assurance data.

I. All fully assembled controls components shall be functionally tested, with fully loaded induction motors. The combined test data shall then be analyzed, to ensure adherence to identified quality assurance specifications.

J. 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.

B. The manufacturer shall furnish all control and wiring diagrams for inclusion in the temperature control system shop drawings.

C. 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.

D. A variable frequency controller shall be provided as indicated on the schedule for each fan and for each pump as noted and/or scheduled on the drawings.

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.
5. Report to the Owner in writing an outline of work performed.

B. Furnish spare parts list.

C. Provide a three (3) year parts and labor warranty for all drives beginning at Substantial Completion.

D. Warranty shall also include travel and lodging expenses for warranty repair personnel as required.

E. All units shall be installed and checked out to be operating as recommended by the manufacturer’s authorized and factory trained start-up agent before warranty begins. This includes completion of a factory authorized representative start-up report.

F. 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 for freeze protection of HVAC piping systems specified herein and as indicated on the Drawings.

B. The heat trace system shall be a commercial grade, electric heating cable type, self-regulating and parallel resistance.

C. 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. The heat trace system shall be UL listed, CSA certified, or FM approved for freeze protection of metal HVAC piping.

D. Materials shall be manufactured by the following.

1. Chromalox
2. Raychem: nVent.

1.4 SUBMITTALS

A. Product Data:

1. Provide product data to allow review of materials and methods to ensure complete compliance with specifications.
2. Submit manufacturer's descriptive literature.
    a. Heating cable data sheet
    b. Data sheets for connect kits and accessories
    c. Data sheets for controllers
3. Submit installation instructions.
    a. Design guides
    b. Install and operation manual
    c. Installation details
    d. Wiring diagrams

B. Shop Drawings:

1. For submitting in this specification section, 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.
2. Coordinate with the mechanical contractor to include in piping shop drawings, the related requirements for heat tracing. Refer to other Div. 23 specification sections.
3. Piping shop drawings shall 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.

C. Closeout Documents

1. Provide final product data submittals.
2. Provide final shop drawing submittals.
3. Provide operation and maintenance data.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site.

B. Products shall be delivered to the site in original, unopened containers or packages with intact and legible manufacturer’s labels.

C. Products shall be stored in a clean, dry location with temperatures within a 0°F-140°F range.

D. Protect the ends of the cables from moisture ingress while stored on site.

E. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

F. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 SELF REGULATING HEAT TRACE

A. Engage manufacturer of heat trace system to design complete and functional heat-tracing system as required by project documents.

B. 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.

C. Heat trace shall be the variable wattage type that adjusts its output based on the temperature to which it is exposed along its length.

D. 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.

E. Heat trace shall be constructed of nickel-coated copper bus wires embedded in crosslinked conductive polymer core whose electrical resistance varies with temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, seal the other end with a watertight end seal. Cable shall be capable of crossing over itself without overheating. 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.

F. Heat trace shall be installed on the following systems located outdoors or when located inside areas of the building subject to freezing:

1. Condenser Water Supply

2. Condenser Water Return
3. Chilled Water Supply
4. Chilled Water Return
5. Domestic Make-Up Water
6. Equalization line or other water filled drains/pipes.

G. 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 unless otherwise approved by the Engineer.

H. See the electrical drawings for circuits provided and rated power.

I. Accessories:

1. Provide end caps for each circuit to close end of heat trace circuit and run heat trace full length of pipe.
2. Provide approved splices (using manufactured splice kits) where a circuit consists of different lengths connected together. Heat trace shall be installed beneath pipe insulation.
3. Provide a thermostatic control device, adjustable, for each heat trace circuit (one controller / circuit) and set at 35°F. Control devices shall be furnished by the heat trace manufacturer and shall include magnetic contactors and overload heaters, if required.
4. Provide a power connection box for each heat trace circuit.
5. The use of power connection kits with integral thermostats is encouraged to eliminate field wiring for control circuits.

J. Size all heat tracing to protect all water filled piping outdoors to -10°F. by wrapping with heat trace wire with thermostats strapped to lines.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Prior to installation of heating cable system, verify that all piping that will be heat traced has passed all hydrostatic/pressure test and is signed off by plumbing inspector.
2. Do not apply heat trace until all piping has been installed, tested, and leaks repaired.
3. After piping is leak-free, clean off pipe and wipe dry to be free of moisture.
4. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Preinstallation Testing:

Prior to installing heating cable on piping, the installing contractor shall perform an insulation resistance test to ensure the integrity of the heating cable is as described in the installation and maintenance manual.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Apply heat tracing in sufficient wattage size and wrap factor to meet specified protection level.

B. Attach heat trace to pipe in accordance with manufacturer's instructions. Do not kink, bend, or break cable.

C. Wrap valves and specialties along with piping to make a continuous system.

D. Splice heat trace with specified splice kits.

E. Connect heat trace to power supply through a power connection kit and thermostat, all of which shall be rated for outdoor, above grade use.

F. Energize heat trace system and set thermostat at 35°F. Verify correct operation and repair any breaks in continuity until system is fully operational.

G. Install insulation and jacketing on piping system over heat trace as 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 01 - General Requirements and referenced documents.

B. For concrete work, refer to Div. 03.

C. For vibration isolation systems related to plumbing systems, see Div. 22.

D. 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

This section includes specifications for complete systems 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/technicians and as recommended by the equipment and vibration isolation manufacturers.

C. Acceptable Manufacturers:

1. Mason Industries
2. Vibro-Acoustics
3. The VMC Group

1.4 SUBMITTALS

A. Product Data

1. Submit manufacturer's descriptive literature and installation instructions for all vibration isolation products and equipment to be provided.
2. Product data shall indicate specific products to be provided. Where submitted data shows multiple products, products not provided shall be noted as such and products to be provided shall be noted as such.
3. The submittal shall indicate the application intended for each product to be provided.

B. Shop Drawings

1. Show and/or note Section 23 05 48 products and equipment on shop drawings to be submitted in accordance with Section 23 05 00.
2. Coordinate with the mechanical contractor to show the location of vibration isolation devices on piping, ductwork, and equipment shop drawings.
3. Provide submittal drawings for vibration isolation bases.

a. Note the dimensions of the base.
b. Note the location and type of isolators to be provided.
c. Note the weights to be supported by the base, including accessories and concrete.

1.5 PRODUCT HANDLING

A. Cover and protect material, products, and equipment in transit and at site.

B. Products and material shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation. Products shall not be stored in environments that may degrade the materials, quality, and/or performance of the products such as environments of extreme high/low temperatures or humidity or dust/debris.

C. Material, products, and equipment not properly protected and stored and which is damaged or defaced during construction shall be rejected. Material, products, and equipment that has become unclean shall be cleaned and inspected to ensure proper operation/function prior to installation.

D. Storage and protection of materials, products, and equipment shall be in accordance with Section 23 05 00.

E. Install materials, products, 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.

E. Springs

1. All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
2. All springs except internal booster springs shall have an outside diameter not less than 80% of the compressed height of the spring.
3. Ends of springs shall be square and ground for stability.
4. Laterally stable springs shall have kx/ky ratios of at least 0.8.
5. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.

F. Rubber Components

1. All rubber components shall be made of Neoprene or EPDM.
2. Rubber compound shall be suitable for outdoor use to withstand UV and ozone exposure when applied in outdoor environments.
3. Mounts, pads, or hanger elements of different durometers within a series shall be color coded for easy identification.
4. Load vs. deflection test data shall be available upon request for all main isolation components and bottom cups that are located under springs.

G. Corrosion Protection

1. All springs shall be powder-coated enamel.
2. Hardware shall be zinc-plated, cadmium, powder-coated, epoxy coated, or PVC finished.
3. Isolator housings shall be galvanized, powder-coated enamel, or painted enamel for indoor use and hot-dip galvanized for indoor or outdoor use.

4. Unless otherwise specified, stands, bases, brackets, anchors, guides, and steel frames shall be prime painted, zinc-plated, black oxide coated, painted enamel, or powder-coated enamel for indoor use and hot-dip galvanized for outdoor use.

H. Capacity Ratings

1. Products that are selected to withstand seismic and wind loads shall have their load capacities in all appropriate axes determined by testing in accordance with ANSI/ASHRAE 171 or through analyses or through an approved combination of both.
2. Supporting test reports shall be made available upon request.

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/Engineer, 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 mechanical rooms, from all the equipment when the various items are in harmony.

2.3 VIBRATION ISOLATOR PRODUCTS

A. Pads

1. Elastomeric isolators may be in pad or molded configurations.
2. Pads are used in single and multiple layers. When using multiple layers, use
3. a bonded (glue or double-sided tape), galvanized sheet metal separation plate between each layer.
4. A load distribution plate may be required to evenly distribute the load over the surface of the pad.
5. Thicknesses may vary for the application.
6. Molded pads
    a. Molded pads shall be molded from a high strength compound with minimum 2,750 psi (19 MPa) tensile strength.
    b. Pads shall be color coded for capacity and sized to deflect 20% of the overall height (e.g., 0.18” (4.5 mm) for 7/8” (22 mm) thick pad).
    c. Maximum allowable deflection is 25% of the overall height (e.g., 0.22” (5.5 mm) for 7/8” (22 mm) thick pad).
    d. Pads shall allow for anchor bolts to be installed through them with or without clamping nuts and without altering the published load vs. deflection performance for a given size.
7. Ribbed pads
    a. Ribbed pads shall be ribbed on both sides.
    b. Pads shall be sized to deflect 20% of the overall height (e.g., 0.07” (2 mm) for 3/8” (10 mm) thick pad).

B. Rubber Isolators

1. Grommet Washers:
    a. Rubber grommet washers shall be of sufficient size to accommodate USS standard washers, long enough to sleeve through 1/4” (6 mm) plate material, and with at least 1/8” (3 mm) thick material around bolt holes.
2. Rubber-in-Shear Floor Mounts:
    a. “Double-deflection” rubber isolators, with rubber-coated metal surfaces, internal threaded holes for securing components, and bolt holes for securing to structure

3. Restrained Rubber-in-Shear Floor Mounts:
    a. “Double-deflection” rubber isolators with mounting brackets and all-directional snubbers for seismic and wind restraint
    b. Snubbers shall include elastomeric components to prevent metal-to-metal contact under normal operation and during a seismic or extreme wind event.
4. Rubber Hangers:
    a. “Double-deflection” rubber hanger isolators, complete with integral rubber sleeves through housing
    b. Rubber elements shall be color-coded to identify load capacities and include either internal or external metal washers to prevent pull-out failure.
    c. Hangers shall be furnished with vertical uplift stop washers where used to support seismically restrained components.

C. Spring Isolators
1. Free Spring Floor Mounted Isolators:
    a. Free-standing, laterally stable, unhoused spring isolators with vertical studs for supporting, leveling, and securing equipment
    b. Springs shall be supported with rubber cups with steel inserts that can be bolted to structure.
    c. Top plates may be added for supporting components.
2. Closed Mount Spring Isolators:
    a. Floor mounted spring isolators with housings and telescoping equipment support plates with vertical studs for securing components
    b. Springs shall be supported either with rubber cups or metal base plates complete with ribbed rubber pads, minimum 1/4” (6 mm) thick, bonded to base plates.
    c. Housings shall incorporate rubber stabilizers to minimize short circuiting and provide vertical damping.
3. Spring Hangers:
    a. Vibration isolator hanger supports with steel springs and welded steel housings
    b. Hangers rated for loads above 200 lbs (0.9 kN) shall be designed for a minimum of 15 degree angular misalignment from vertical before support rod contacts housing.
    c. Spring hangers shall be furnished with vertical uplift stop washers where used to support seismically restrained components.

D. Restrained Spring Isolators
1. Laterally stable, restrained spring isolators with welded steel housings and heavy top plates for supporting components (vertical studs may be used).
2. Springs shall be supported with rubber cups (steel inserts may be used).
3. Housings shall include restraining limit stops (hold-down plates) or integral, all-directional limit stops.
4. Isolators may be furnished with factory installed oversized base plates for anchor load distribution purposes where required.

E. Thrust Restraints
1. Spring assemblies used to limit the motion of base-mounted or suspended fans due to aerodynamic thrust forces.
2. Thrust restraints shall be designed for use in pairs of assemblies and include all brackets and hardware necessary for installation, precompression, and adjustment.
3. Operating clearances shall be nominal ¼” (6 mm) to ensure no short circuiting of isolation.

F. Air Springs

2.4 VIBRATION ISOLATION BASES

A. Concrete Inertia Base:

1. Inertia bases shall be of welded steel or formed sheet metal construction with concrete in-fill supplied by the installing contractor on site and shall incorporate minimum #4 (or 10M) reinforcing bars, welded 12” (300 mm) to 18” (455 mm) maximum on centers each way.
2. Inertia bases for end suction and split case pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections.
3. The weight of each inertia base shall be at least equal to the weight of the equipment mounted thereon.
4. Inertia bases shall be of minimum 6” (150 mm) thickness.
5. Height-saving brackets or welded steel pockets shall be incorporated to ensure a 1-1/2” (40 mm) minimum clearance under each base.
6. Equipment bolting templates shall be provided when required or scheduled.
7. Bottom pans may be provided as a contractor option but shall be minimum 16ga (1.6 mm) sheet metal.

2.5 FLEXIBLE CONNECTORS

A. Flexible Pipe Connectors

1. Braided Metal Flexible Connector
2. Corrugated 300 series stainless steel bellows or bronze bellows flexible connectors with stainless steel or bronze braiding connected to braid collars and pipe fittings at each end.

B. Flexible Duct Connectors (see Section 23 33 00 – Air Duct Accessories).

PART 3 - EXECUTION

3.1 VIBRATION ISOLATION

A. GENERAL

1. Block and shim all bases level so that all piping and electrical connections can be made to a rigid system at the proper operating level before isolators are adjusted. Ensure that there are no rigid connections or incidental physical contacts between isolated equipment and the building structure or nearby systems.
2. Secure base-mounted pumps, as indicated in this Section or on the drawings, to concrete-filled inertia bases. Concrete in-fill shall be supplied by the installing contractor on site.
3. Ensure that HVAC equipment housekeeping pads are level.
4. Select and locate vibration isolators to provide similar loading and deflection, according to weight distribution of equipment.
5. Coordinate materials and connection styles for inline flexible connectors and expansion joints with isolation supplier, e.g., ANSI B16.5 Class 150 steel flanges for flanged pipe connections.

B. Pipe Isolation

1. 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 two (2) per pipe.
2. These spring hangers shall also serve to dampen vibration transmission to the building.
3. Provide other spring hangers for pipes, compensators, etc., as required to comply with the vibration transmission limits listed.

C. Equipment Isolation

1. Pumps

a. Provide concrete inertia base with spring isolators for floor mounted pumps.
b. Spring isolators shall have a minimum 2” deflection.
c. Provide ribbed pad bonded to base plate.

d. Inertia base shall be installed on 4” thick concrete housekeeping pad.
e. Inertia bases shall be configured to include supports for pipe elbows where pipes connect to the pump.
f. Springs for inertia bases shall not extend beyond the inertial bases, but shall be recessed in its footprint.

2. Fans

a. In-line, interior fans

1) Isolators for fans suspended from above on rod hangers, not internally isolated, shall be of the open spring type with housings and noise washers, lock washers, nuts, etc.
2) Isolators shall have a minimum 1-inch deflection.
3) Fans less than 1,000 CFM in capacity may be isolated with rubber-in-shear isolating grommets in lieu of spring isolators.

b. Roof Curb Mounted Fans

1) Curb mounted fans shall be isolated with 2” wide 3/8” thick neoprene isolation strips.
2) Isolation strips shall be installed continuously between the curb and fan.

3. Air Terminal Units

a. Isolators for units suspended from above on rod hangers, not internally isolated, shall be of the open spring type with housings and noise washers, lock washers, nuts, etc.
b. Isolators shall have a minimum 1-inch deflection.
c. Units less than 1,000 CFM in capacity may be isolated with rubber-in-shear isolating grommets in lieu of spring isolators.

4. Boilers

a. Provide direct isolation.
b. Provide waffle/ribbed style rubber/neoprene isolation pad between boiler and concrete housekeeping pad.

5. Cooling Towers

a. Provide direct isolation as required.
b. Coordinate with cooling tower manufacturer’s recommendations and structural engineer’s plans for tower base / platform.

6. Packaged Water-Cooled Water Chillers

a. Provide direct isolation.
b. Provide restrained spring isolator.
c. Provide flexible pipe connector at pipe connections to chiller.

7. Air-Handling Units

a. All air handling units are internally isolated, except for those handling less than 6,500 CFM.
b. For air handling units that are internally isolated, provide vibration isolation pads to be placed under the unit’s load points, plenum, and accessories so that there is no metal-to-concrete contact.
c. Provide waffle style neoprene isolation pads beneath all floor mounted air handling units to include plenum and duct sections supported from the floor.

8. Roof Mounted Air-Conditioning Units

a. Curb mounted units shall be isolated with 2” wide 3/8” thick neoprene isolation strips.
b. Isolation strips shall be installed continuously between the curb and unit.

3.2 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.

D. 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.

3.3 INSTALLATION

A. Installation of vibration isolation products shall be in accordance with the manufacturers’ written instructions.

B. Vibration isolation products shall be aligned and shall not result in stress on pipes or equipment.

C. The contractor shall consult with the vibration isolation manufacturer for installation procedures.

END OF SECTION

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SECTION 23 05 53

IDENTIFICATION FOR HVAC

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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 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.

D. Provide a complete system of device 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. To meet all ANSI standards pertaining thereto, manufactured piping identification markers, equipment name plates, and valve tags shall be a product manufactured by the following.

1. Seton Name Plate Corporation
2. EMED Company, Inc.
3. Craftmark

C. Equipment identification labels’ wording shall be subject to Owner review.

1.4 SUBMITTALS

A. Product Data:

1. Submit a list of all piping systems to be identified. Include in the list the system type, color of background to be used, legend or wording to be displayed for each system, and the product to be used.
2. Submit a list of equipment to receive identification tags.
    a. Include the equipment designation as it will be on the tag and the product to be used.
    b. Submit cut sheets and proof copy images of tags which indicate location of tag and wording to be engraved thereon.
3. Submit a list of valves indicating location, type of service, type of tag, and tag number. Submit proposed valve tag chart as specified herein.
4. Submit manufacturer's descriptive literature and installation instructions in accordance with Section 23 05 00.

B. Shop Drawings:

1. For the shop drawings to be submitted in accordance with Section 23 05 00, please include the intended location of all pipe markers to be displayed.
2. For the shop drawings to be submitted in accordance with Section 23 05 00, please include the intended location of all equipment tags to be displayed.
3. For the shop drawings to be submitted in accordance with Section 23 05 00, please note the intended location for mounting the valve tag charts.

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. Provide piping identification markers for all insulated and uninsulated piping systems in sizes and colors in accordance with ANSI Standard A13.1.

B. Markers shall be equal to Seton Name Plate Corporation vinyl plastic wrap around "Setmark" pipe markers.

1. Provide with flow arrows when identifying systems that flow to indicate flow direction.
2. For systems with overall outside diameters under 6" use the snap-around markers.
3. For systems with overall diameters 6" and over use strap-around markers attached with nylon ties.

C. Markers on pipes located outdoors shall be rated for outdoor use with UV protection.

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

1. Primary Chilled Water Supply (Green Background, White Letters)
2. Primary Chilled Water Return (Green Background, White Letters)
3. Chilled Water Supply (Green Background, White Letters)
4. Chilled Water Return (Green Background, White Letters)
5. Make, Up Water (Green Background, White Letters)
6. Drains—Condensate Drains, Auxiliary Drains and basic system Drains (Green Background, White Letters)
    a. For all insulated drains not contained in one space or on the roof labeling in not required. Other drains shall be labeled. For example, an A/C condensate drain in a mechanical room shall not require identification, whereas, as drain extending to another space would.
    b. Label each drain line based on its contents; primary condensate drains shall be labeled different than auxiliary drains.
7. Primary Heating Water Supply (Yellow Background, Black Letters)
8. Primary Heating Water Return (Yellow Background, Black Letters)
9. Heating Water Supply (Yellow Background, Black Letters)
10. Heating Water Return (Yellow Background, Black Letters)
11. Condenser Water Supply (Green Background, White Letters)
12. Condenser Water Return (Green Background, White Letters)
13. Refrigerant Suction Piping (Green Background, White Letters)
    a. Min. ½” lettering height
    b. Note Safety Group classification for the refrigerant
    c. For Group A2, A3, B2, and B3 refrigerants, include the wording “DANGER — RISK OF FIRE OR EXPLOSION. FLAMMABLE REFRIGERANT” in addition to the system abbreviation.

d. For any Group B refrigerant, include the wording “DANGER — TOXIC REFRIGERANT” in addition to the system abbreviation.

14. Refrigerant Liquid Piping (Green Background, White Letters)

a. Min. ½” lettering height
b. Note Safety Group classification for the refrigerant
c. For Group A2, A3, B2, and B3 refrigerants, include the wording “DANGER — RISK OF FIRE OR EXPLOSION. FLAMMABLE REFRIGERANT” in addition to the system abbreviation.
d. For any Group B refrigerant, include the wording “DANGER — TOXIC REFRIGERANT” in addition to the system abbreviation.

15. Piping with Electric Heat Trace

a. White letters on Grey background
b. Wording to be “ELECTRIC HEAT TRACED”

E. Refer to Division 09 for color code paint requirements for all exposed mechanical equipment and piping.

F. For piping routed on the floor of mechanical equipment rooms that pose a trip hazard, please provide yellow PVC jacketing equal to Johns Manville Zeston 200 Series Color PVC.

1. Provide fitting covers.
2. Material shall be a min. 20 mill thickness.
3. Product shall comply with ASTME E84 for flame and smoke spread.

2.2 EQUIPMENT IDENTIFICATION

A. Equipment Located in Building Interior in equipment room

1. This Contractor shall provide identification plates similar and equal to Seton Name Plates, Style 15671(M4564).
2. Name plates shall be a minimum of 1/16" thick flexible multi-layered acrylic and be 1" X 3" in size with beveled edges.
3. The surface shall be a black satin with a white core for lettering. Other color combinations may be used for specific systems where warranted.
4. Each plate shall be drilled with two mounting holes sized for 3/8" No. 3 round head nickel plated steel screws.
5. 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”.
6. Only name plates equal to those specified will be considered.
7. No punched plastic tape or engraved aluminum plates are acceptable.
8. Stick-on only plates are not acceptable.
9. Furnish 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 the following.

a. Pumps
b. Piping specialty equipment (i.e. air separators, expansion tanks).
c. VFDs
d. Fans
e. Hoods
f. Air Terminal Units
g. Boilers
h. Chillers
i. Air-Handling Units
j. Unit Heaters

B. Equipment Located in Building Interior, concealed above ceiling

1. This Contractor shall provide identification plates similar and equal to Seton Name Plates, Custom Engraved Plastic Equipment Nameplates.
2. Name plates shall be a minimum of 1/16" thick flexible multi-layered acrylic and be 2.5” wide by 0.75” high.
3. The surface shall be a white with a black lettering.
4. Each plate shall be mounted by means of adhesive.
5. Only name plates equal to those specified will be considered.
6. Furnish and install identification plates on ceilings below equipment concealed above ceilings such as the following.

    a. Fans
    b. Air Terminal Units

C. Equipment Located Outside Building

1. This Contractor shall provide identification plates similar and equal to Seton Name Plates Custom Engraved Aluminum Equipment Nameplates.
2. Nameplates shall be approximately 0.20 inches thick.
3. Nameplates shall be a minimum 3” wide by 1” high.
4. The text shall be natural on a black background.
5. Each plate shall have two 3/16” side holes and 3M 467 adhesive.
6. Furnish 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 the following.

    a. Fans
    b. Cooling Towers
    c. Roof Mounted Air-Conditioning Units.

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.

E. Prior to ordering tags, Contractor shall verify with Owner exact wording on mechanical equipment tags per Owner’s direction.

2.3 VALVE TAGS

A. Install on the handle of each valve installed a 20-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, "HVAC" for Heating, Ventilation, and 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. Refer to Division 21 and 22 requirements for plumbing and fire protection system tags.

B. Secure valve tags to valves by use of 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 in each building for the valves in that building with typed schedule sheets contained therein. Charts shall have an aluminum frame with clear plastic or Lexan window. Install charts in condenser water riser rooms.

2.4 CONTROLS INSTRUMENTATION

A. Where labels are not integral to a manual interface device, provide identification for HVAC controls interface devices such as switches.

B. The product used for this identification shall be a black vinyl plaque with white letters.

C. Label width shall be min. 2½", max. 3" and a height min. ¾", max. 1".

D. Wording of label shall indicate the purpose of the device (example: "ROOM EXHAUST FAN" shall be placed by the switch that activates the exhaust fan for a particular room).

PART 3 - EXECUTION

3.1 PIPE MARKER INSTALLATION

A. Provide flow arrows at each marker location to indicate fluid flow in pipe.

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.

C. Identification markers shall be installed on all new piping; indoors, outdoors, and in the crawl space.

D. Install markers on exposed piping systems only after jacketing systems and finish paint coats are complete. Refer to Division 09 and Section 23 07 00.

E. Round pipes shall receive wrap-around type markers.

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 tags with screw fasteners after secured with adhesive (where specified to receive screw mounting).

C. Install tags on ceilings below equipment installed concealed above ceilings.

D. Install valve markers on ceilings below valves that are installed concealed above ceilings.

E. Install device tags in a conspicuous location that allows the device to be easily identified.

3.3 FIRE, SMOKE, AND COMBINATION SMOKE-FIRE DAMPER IDENTIFICATION

A. Fire, smoke, and combination smoke-fire dampers shall be identified at points of access.

B. Refer to Section 23 33 00 – AIR DUCT ACCESSORIES for requirements related to the identification of fire, smoke, and combination smoke-fire dampers.

3.4 VALVE TAGS

A. Secure Valve tags to each valve with brass jack chains on each valve stem corresponding to the valve tag chart list.

B. Secure Valve Tag Chart List to Mechanical Room wall near the main entry to the room, at 60" above finished floor or where otherwise directed by the Architect.

C. Provide chart data to Owner for their disposition.

END OF SECTION

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

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 Division 22 for Plumbing work associated with this section's scope of work.

C. 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 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.

C. The TAB work shall be bid directly to the general contractor.

D. Only the following pre-qualified firms shall be acceptable.

   a. Engineered Air Balance (EAB)
   b. Delta-T Ltd.
   c. Air Balancing Company

E. The TAB Firm is responsible to and shall submit all reports directly to the Architect/Engineer and as requested, to the Owner.

F. TAB services shall result in the optimum temperature, humidity, airflow, ventilation rates, and noise levels in the conditioned spaces of the building.

G. The following basic components of the mechanical systems shall be tested, adjusted, and balanced:

   1. Domestic hot water recirculation pumps and related balancing valves
   2. Control systems
      a. Verification to include end devices
      b. Verification to include control sequences of operation
      c. Verification to include energy management system control
      d. Monitoring point verification
   3. Pumping systems
   4. Air distribution systems
   5. Air moving equipment
   6. Heating systems
   7. Cooling systems
   8. Packaged HVAC equipment

H. 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 manufacturers' submittal data relative to balance ability.
3. TAB Firm shall review submitted automatic building management system control sequences for conformity to the specifications.

I. The final report shall be submitted to the Owner, or representative thereof, and the Engineer of Record. The final report shall include a summary of actual operating data and any abnormal operating conditions unresolved or accepted. The report will contain all required information as described within this specification. The format of the final report may be in .pdf format or if physical copies are provided, they shall be three (3) hard bound copies.

1.3 SERVICES OF MECHANICAL CONTRACTOR

A. The Mechanical 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 or the specification requirements, whichever is the more stringent. All equipment shall operate a sufficient length of time at the Mechanical 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 Plumbing systems can be properly tested, adjusted, and balanced, the Mechanical Contractor shall operate the systems at his 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. Operating expenses to be paid for by the Mechanical Contractor (not TAB firm) will include, but is not necessarily limited to, the following:

1. Utility costs; electrical, water, gas, etc., as applicable.
2. Personnel costs to start, operate and stop all mechanical 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 systems to obtain optimum operating conditions. It will be the responsibility of the Mechanical 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 Mechanical Contractor shall provide access as required by the TAB firm.

D. The Mechanical 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 Mechanical 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. Coordinate with the General Contractor and TAB Firm to maintain the proper schedule of work to meet Owner expectations.

G. The Mechanical Contractor shall, in cooperation with the General Contractor, furnish without charge to the TAB Firm:

1. One set of mechanical specifications.
2. All pertinent change orders and Addenda.
3. Two complete sets of mechanical plans with latest revisions (or digital copy).
4. "As-installed" drawings.
5. Approved control product data, diagrams, and shop drawings.
6. Approved manufacturer's submittals for all plumbing and HVAC equipment.

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, and building envelope complete, to permit the obtaining of projected actual operating conditions.
2. Automatic Controls:
    a. 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.
    b. Verify that all controlling instruments are calibrated and set for designed operating conditions with the exception of room thermostats which shall be calibrated at the completion of TAB services with cooperation between TAB Firm and controls system installer.
    c. 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 (technicians and necessary hardware and software) to the TAB agency to allow for a complete check out of these systems. The controls contractor shall be on site with the TAB contractor as needed to assist the TAB firm in completing TAB work.
    d. The controls system installer shall also provide trending reports with the specific points and trend intervals, as requested by the TAB contractor when abnormal conditions are experienced.
    e. The scope of the TAB work as defined herein is indicated in order that the contractor will be apprised of his 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.
3. Water Circulating Systems (includes those from Division 22 – Plumbing):
    a. 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.
    b. Open all valves to full open position. 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.
    c. Check and verify pump alignment and rotation.
    d. 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.
    e. Verify specified vibration isolation accessories are correctly installed and adjusted.
    f. For domestic water systems, include start-up, checkout, and verification of all thermostatic mixing valves, pumps, and operation thereof.
4. Air Distribution Systems:
    a. Verify installation for conformity to design of all outside air, supply air, return air, and exhaust air ducts.

b. 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.
c. Verify that all volume dampers, backdraft dampers, smoke dampers, fire dampers, and combination fire-smoke 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.) locations.

    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.
    4) Verify that minimum outside air, and relief air dampers provide tight closure, open fully and operate smoothly and freely.
    5) Verify that backdraft dampers start opening at 0.01 in. w.g., fully open at 0.07 in. w.g., and close fully. Balance counterweights as required.

d. Provide additional air balance dampers, replacement sheaves, and belts as required for successful TAB work.
e. Flag all air balance dampers with fluorescent or other high visibility tape, leaving a minimum of one inch (1”) wide by three inches (3”) long exposed to view.
f. Verify that all supply air, return air, exhaust air and transfer air diffusers, grilles and registers are installed as indicated on the Mechanical Drawings.
g. Verify that all supply air and exhaust air fans are operational including proper fan rotation, that the fan operates free from vibrations, belts are properly aligned, and belt tension is proper.
h. Ensure 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.
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, per phase, and verify that they do not exceed nameplate ratings.
k. Verify specified vibration isolation accessories are correctly installed and adjusted.
l. Verify that the correct size and type of air terminal units are installed as indicated on the mechanical drawings and that they are fully operational.
m. Verify that central-station air-handling units with their associated components and systems (heating coils, cooling coils, filters, access doors, etc.) have been installed and are sealed appropriately for each section and interior component.
n. Install the specified type and quantity of clean filters at each air handling unit or filter grille, and maintain these filters for the complete period that the subject system is being tested, adjusted, and balanced. New filters shall be installed for TAB work to ensure that clean filters are the basis for TAB test data.

5. Boilers

a. 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.
b. Verify that electrical circuits, control, and power, have been properly and permanently installed and connected, with circuit protective devices correctly sized and calibrated.
c. Verify that specified vibration isolation accessories are correctly installed and adjusted.
d. Record the voltage and amperage at each heating element and each motor, per phase, and verify that name plate values are not exceeded.

e. Verify that all piping connections have been made in accordance with the manufacturer's recommendations, and specification and drawing requirements.
f. Verify that flue gas vent piping has been correctly installed in accordance with the boiler manufacturer's recommendations and these specifications.
g. Verify that the proper draft has been achieved for each boiler burner system.

6. Cooling Towers

a. Verify that the specified start-up and check-out of each cooling tower cell was accomplished by the approved representatives of the equipment manufacturer, and that any necessary adjustments have been made in conformance with recommendations thereof.
b. Verify that cooling tower fans are operating at the intended speed, that fan drives are properly adjusted, and that fan motors do not draw more than their name plate current, for each phase.
c. Verify that balancing valves have been adjusted to provide intended flow into each hot water basin.
d. Verify that electrical circuits, control, and power have been properly installed and connected, with all circuit protective devices correctly sized and calibrated.
e. Verify installation and intended operation of basin heaters, and controls, including low water level safety controls to prevent operation of heaters when not submerged in water.
f. Verify installation and intended operation of electrical heating tape provided for freeze protection of outdoor piping.
g. Check towers for proper operating water levels, correct settings of float switches or valves, and for nozzle spray patterns.
h. Verify that specified vibration isolation accessories are correctly installed and adjusted.
i. Verify the operation of any safety devices to include vibration cut-out switches for each tower fan.

7. Water Chillers

a. Verify 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.
b. Verify that electrical circuits, control, and power, have been properly and permanently installed and connected, with circuit protective devices correctly sized and calibrated.
c. Verify that specified vibration isolation accessories are correctly installed and correctly adjusted.
d. Record the voltage and amperage at each motor, per phase, and verify that name plate values are not exceeded.

8. Decentralized, Packaged HVAC Equipment

a. Verify that specified start-up and check-out processes have been accomplished by trained technicians and that necessary adjustments have been made to satisfy start-up requirements.
b. Verify that electrical circuits, control, and power have been provided.
c. Verify that vibration isolation devices have been provided.

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.
2. TAB Firm shall have operated a minimum of ten (10) years, under its current firm name.
3. 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.
4. 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 Professional Engineer and key personnel to be assigned to this project
b. Proof of company operation for a minimum of ten (10) years
c. Proof of 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, and Owner group and the 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 or deficiency log 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 next test will be required. Document tests witnessed in writing.

C. TAB Firm Services:

1. TAB personnel shall witness duct pressure tests.
2. 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.
3. 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. Pumps:

1) Verify, by witnessing, that the start-up strainers are removed and replaced with final strainers which are clean and of the proper type.
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 flow 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) Balance all heat transfer devices proportional to within $\pm$ 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 VFDs set at 60 Hz, where applicable).

11) Verify all interlocks and flow switches are installed and operating properly to include minimum differential set points for differential pressure type flow switches.
12) Test and record entering and leaving air and water temperatures at all heat transfer devices, as applicable (refer to individual heat transfer device and condenser coil data requirements).

b. Air Distribution Devices:

1) Preset all volume dampers in the 100% open position.
2) Set counterweight backdraft dampers to start opening at 0.01 in. w.g., fully open at 0.07 in. w.g., and close fully. Balance counterweights as required.
3) Determine and verify proper air pattern deflection devices have been installed.
4) Verify size and types of all air devices installed, versus, the sizes and types indicated on the Drawings.
5) Read out all air distribution devices served by their source (Unit, Supply Fan, Exhaust Fan, etc.)
6) Balance all air distribution devices proportional to design CFM.
7) Adjust source to design CFM.
8) Verify that all air distribution devices are within plus or minus 10% of design (and all proportional to one another on each system).

c. Fire, Fire-Smoke, and Smoke Dampers:

1) Verify operation of all fire, 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.
4) Verify each duct access damper has suitable access through general construction features.
5) Witness the Contractor testing each fire, 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.
6) Witness each fire, 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.
7) Verify that all fire dampers are fully opened.
8) Identify all dampers requiring repair or having a faulty installation.
9) Write down pertinent information on damper testing tags to verify dates tested and initials of tester to confirm a successful test was conducted.

d. HVAC 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 1,000 feet

per minute or greater. If the duct main is not suitable for traverse, then traverse branch duct 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) Balance air distribution system (see Air Distribution Devices).
9) Witness positive pressure duct leakage tests performed by the contractor.

e. Air Terminal Units

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 electric and 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.

f. Boilers:

1) General Instructions:

a) Take and record the following readings on each boiler (readings shall be taken as nearly simultaneously as possible).
b) Boilers shall be tested with the manufacturer's representative present.
c) Readings shall not be taken on components such that manufacturer's warranty would be voided.

2) Record the following:

a) Manufacturer/model/serial number
b) Energy source - type fuel(s)
c) Capacity ratings, input and output
d) Hot water system working pressure
e) List electrical loads, with name plate, versus actual electrical characteristics for each motor (Volts and Current, per Phase)
f) Check and note water level controls (feeders and low water cut-offs).
g) Check and note operation of operating and limit controls (hot water cut-out temperature).
h) Check and note safety valves for conformance to boiler manufacturer's recommendations, and for settings.
i) Verify and note operation and correct setting of each differential pressure flow proving switch.

g. Cooling Tower

1) General Instructions

a) Conduct capacity performance tests generally in accordance with the Cooling Technology Institute (C.T.I.) recommendations.
b) A full Certified CTI test is not required.

c) Take and record the following readings on each cooling tower (readings shall be taken as nearly simultaneously as possible).

2) General Data

a) Tower Manufacturer/model/serial number.
b) Number of fan motors.
c) Motor manufacturer/frame size/horsepower.
d) Motor Name Plate RPM(s).
e) Name plate Volts/Phase/Hertz.
f) Motor sheave diameter or gear pitch diameter.
g) Fan sheave diameter or gear pitch diameter.
h) Belts: Number/manufacturer/size.
i) Ambient wet bulb temperature.
j) Fan RPM(s).
k) Voltage.
l) Amperes.
m) Entering water pressures, PSIG.
n) Entering and leaving water temperatures, Deg.F.
o) Water temperature drop, Deg.F..
p) GPM through each tower cell and to each warm water basin.

h. Packaged Water Chillers:

1) General Instructions:

a) Take and record the following readings on each refrigeration machine (readings shall be taken as nearly simultaneously as possible).
b) Readings on refrigeration machines shall be taken from gauges or indicating devices supplied with the machines.
c) Readings shall not be taken on components that would void machine warranty.
d) Manufacturer's authorized representative shall be present to assist in taking readings.
e) All these tests shall be conducted at full load, and at each of the part-load conditions listed elsewhere in other Sections of these Specifications.

2) General Data:

a) Equipment designation, Make, & Model
b) Scheduled capacity
c) Refrigerant type
d) Starter manufacturer, size, and type
e) Overload heater sizes
f) Low temperature safety cut-out setting
g) Demand limit set-point

3) 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)

4) Compressor

a) Make/model/serial number
b) Type of Compressor
c) Voltage for each compressor
d) Current draw (amperes) for each compressor
e) Chilled water control setting
f) Condenser water control setting

g) Low temperature cut-out setting

5) Condenser (Water-Cooled)

a) Enter and leaving water pressures
b) Water pressure drop
c) Entering and leaving water temperatures
d) Water temperature drop
e) GPM through condenser.

i. Cooling and Heating Coils:

1) Verify that all water connections, valves, and accessories are installed per the design documents, as applicable.
2) Verify that all coils 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. Air Handling 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.
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 (firestat, 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, return air CFM relationship to design, or other purpose specified or noted.
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.

k. Packaged Rooftop Air-Conditioning Units

1) Verify that the outside, return and relief dampers are operational and move freely.
2) Verify that filters are 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.
5) Verify that all RTU safeties are operational, as applicable, (low and high pressure limit switches, freezestat, high static pressure, anti-recycle timer, etc.).
6) Verify correct size and rating of motor overload protection for each fan motor.
7) Verify each fan motor is not overloaded; amperage readings do not exceed motor nameplate rating.
8) Determine total supply and return air. Air quantities to be determined by duct traverse if duct configuration permits and air velocity is 1,000 feet per minute or greater.
9) Balance air distribution system.
10) 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. After adjustments are made, retest units to determine final air balance quantities.
11) 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.
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.

4. 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.
5. 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 contractor can recalibrate, using data supplied by the TAB Firm as required.
6. 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°F. of the temperature, 5.0% for relative humidity, 25 parts per million (PPM) for carbon dioxide, and 0.01% for pressure of the actual variables measured in the field, with recently calibrated test equipment, at the sensor locations.

7. 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.
8. Make not less than three (3) inspections within ninety (90) days after occupancy of the building, and make adjustments, if required, to ensure 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.
9. 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.
10. 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 systems balanced. 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.
4. Pumps:

   a. Manufacturer, model, size and serial number.
   b. Actual pump suction and discharge pressures.
   c. Design and actual pumping head.
   d. Design and actual GPM.
   e. Motor nameplate data.
   f. Motor starter data and motor overload protection (heater) sizes and rating.
   g. Actual motor amperage and voltage (all phases).

5. Air Distribution Devices (Supply, Exhaust, Return, and Relief Air type where Balance Dampers are Used):

   a. Manufacturer, model and size (include neck sizes).
   b. Location.
   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.)

6. HVAC Fans:

a. Manufacturer, model and size.
b. Design and actual CFM.
c. Design and actual fan RPM.
d. Design and actual static pressure (leaving minus entering).
e. Motor nameplate data.
f. Motor starter data and motor overload protection (heater) sizes and rating.
g. Actual motor amperage and voltage (all phases).

7. Fire, Fire-Smoke, 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.

8. Air Terminal Units:

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.).

9. 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.

10. Cooling Towers:

a. Manufacturer, Model, size and serial number.
b. Rated Capacity, GPM, tons of cooling and motor nameplate data.
c. Entering Water Temperature per cell, Deg.F.
d. Leaving Water Temperature per cell, Deg.F.
e. Water flow rate, GPM to each cell.
f. Entering water pressure to each cell in feet or PSI.
g. Fan motor running amps and rpm, high speed, per cell.
h. Fan motor running amps and rpm, low speed, per cell, if 2-speed fans are used.
i. Fan motor rated amps and rpm, high speed, per cell.
j. Fan motor rated amps and rpm, low speed, per cell, if 2-speed motors used.
k. Basin Heater voltage and amps per heater compared to nameplate.

11. Packaged Water 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.
    f. Design and actual condenser water pressure drop (entering and leaving pressures).
    g. Design and actual condenser water flow rate, GPM.
    h. Design and actual entering and leaving condenser water temperature at 100% load.
12. Indoor Central-Station Air-Handling Units:
    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.).
13. Cooling/Heating Coils and Heat Exchangers:
    a. Manufacturer.
    b. Design and actual CFM.
    c. Design and actual entering and leaving air static pressures.
    d. Design and actual entering air temperatures.
    e. Design and actual leaving air temperatures.
    f. Actual outside air temperature during testing.
    g. Design and actual entering water temperature.
    h. Design and actual leaving water temperature.
    i. Design and actual coil pressure drop.
    j. Design and actual GPM.
14. 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:

1. 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.
2. Provide TAB technicians to assist as required in making such tests.
3. 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

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SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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. Coordinate with piping identification systems as specified in Section 23 05 53, Identification for HVAC Piping and Equipment.

D. Coordinate with heat tracing requirements as specified in Section 23 05 33, Heat Tracing for HVAC Piping and as noted on drawings.

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. Insulations shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.

C. Fiberglass insulations shall be constructed of bio-soluble fiber, certified by EUCEB.

D. Fiberglass insulations shall have a minimum of 50 percent recycled glass content; certified and validated in accordance with UL 2809 Environmental Claim Validation Procedure for Recycled Content.

E. Fiberglass insulations shall have a bio-based, formaldehyde-free binder and be UL GREENGUARD Gold and UL validated formaldehyde-free.

F. Products shall have Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723. Where pipe or duct insulation is in a plenum, the insulation shall be listed and labeled.

G. Approved Manufacturers:

1. Fiberglass Insulation
    a. CertainTeed
    b. Johns Manville
    c. Knauf Insulation
    d. Manson Insulation

e. Owens Corning

2. Elastomeric Foam

a. Armacell
b. Aeroflex
c. K-Flex.

3. PVC Jacket / Fitting Covers

a. Johns Manville
b. Proto Corporation
c. P.I.C. Plastics

4. Aluminum & Stainless Steel Jacket / Fitting Covers

a. Johns Manville
b. RPR Products

5. Mastics, Coatings, Sealants, & Adhesives

a. Childers
b. Foster
c. Vimasco Corporation
d. MEI / Mon-Eco Industries.

6. Fire-Rated Insulation

a. 3M Company
b. Alkegen / FryeWrap / Unifrax.
c. Morgan Advanced Materials Thermal Ceramics FireMaster

1.4 SUBMITTALS

A. Product Data:

1. Submit a summarized table indicating each system receiving insulation and the insulation products to be provided for the system. Include insulation and jacketing. Include method of application. General statements not specifically identifying means or methods to be used shall be cause for rejection.
2. Submit 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. Where a product lists options, please note what options will be provided or strike out those that will not be provided to clearly indicate what will be provided.
3. Submit manufacturer's descriptive literature and installation instructions to allow review of Materials and Methods to ensure complete compliance with specifications.

B. Shop Drawings: When shop drawings are submitted in accordance with 23 05 00, the contractor submitting the shop drawings shall show and indicate insulation to be provided.

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. HVAC Insulation products and materials shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

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

D. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. General

1. Refer to Part 3 of this specification for insulation requirements for pipe systems to be used in this project.
2. Comply with Quality Assurance requirements previously stated.

B. Fiberglass Pre-Formed Pipe Insulation

1. Glass fibers bonded with a bio-based thermosetting resin
2. One piece, mandrel wound construction with factory pre-slit sidewall
3. Compliances:
    a. ASTM C547, Type I and IV;
    b. ASTM C585
    c. ASTM C411
    d. ASTM C795
    e. NFPA 90A and 90B,
    f. UL Environment GREENGUARD, Gold certified
    g. UL Validated formaldehyde-free,
    h. UL Validated for recycled glass content of 50% minimum
    i. Bio-soluble certified by EUCEB, and
    j. UL Listed as Plenum Rated (for installation in plenums)
    k. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.
4. Performance Requirements:
    a. Maximum service temperature of 1,000°F.
    b. Thermal conductivity (k-value) at 75°F mean temperature shall be 0.23 Btu x in. /h x sq. ft. x °F, or less.
5. Provide with factory applied white ASJ SSL or white ASJ+ SSL+ vapor retarder jacket with self-sealing lap closure and butt strips, complying with ASTM C1136.
6. Acceptable Products:
    a. Knauf Insulation: Earthwool 1000 Pipe Insulation with ECOSE.
    b. Manson Insulation: Alley-K Pipe Insulation with ECOSE.
    c. Others by listed manufacturers meeting physical and performance properties
        1) Johns Manville
        2) Owens Corning

C. Fiberglass Pipe Insulation – Segmented, Semi-Rigid:

1. Glass fibers bonded with a bio-based thermosetting resin
2. Semi-rigid, segmented board in roll form with glass fibers adhered perpendicular to the vapor retarder facing
3. Compliances:
    a. ASTM C1393, Category 1.
    b. Compressive strength per ASTM C165, not less than 120 PSF at 10% deformation
    c. Must be NFPA 90A and 90B compliant,
    d. UL Environment GREENGUARD Gold certified
    e. UL Validated Formaldehyde-free
    f. UL Validated for Recycled Glass Content of 50% minimum
    g. Bio-soluble certified by EUCEB
    h. UL Listed as Plenum Rated (for installation in plenums)

i. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.

4. Performance Requirements:
   a. Maximum service temperature of 850 degrees F.
   b. Thermal conductivity (k-value) at 100 degrees F mean temperature shall be 0.26 Btu x in. /h x sq. ft. x degrees F, or less.
5. Provide insulation with factory-applied vapor retarder facing complying with ASTM C1136.
6. Acceptable Products:
   a. Knauf Insulation; Earthwool Pipe & Tank Insulation with ECOSE.
   b. Manson Insulation; Earthwool Pipe & Tank Insulation with ECOSE
   c. Others by listed manufacturers meeting physical and performance properties
      1) Johns Manville
      2) Owens Corning

D. Flexible Elastomeric Insulation

1. Closed-cell thermal pipe insulation
2. Comply with ASTEM C 534, Grade 1, Type I for tubular materials.
3. Must be NFPA 90A and 90B compliant
4. UL Environment GREENGUARD Gold certified
5. UL Listed as Plenum Rated (for installation in plenums)
6. Manufacturer from list provided in Quality Assurance paragraph previously provided
7. Acceptable Products:
   a. AP ArmaFlex
   b. AP ArmaFlex Black LapSeal
   c. Aeroflex EPDM

E. Mastics, Coatings, Sealants, Adhesives, Cements

1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless noted otherwise.
2. Refer to Quality Assurance paragraph for acceptable manufacturers.

F. Protective Finish Jacket and Fittings

1. PVC Jacket
   a. Comply with ASTM C1917
   b. Thickness:
      1) Indoors: 0.020 inches
      2) Outdoors: 0.030 inches
2. PVC Jacket Fitting Covers
3. Aluminum Jacket
   a. Comply with ASTM B C1729.
   b. Thickness: 0.016 inches
   c. Locked seams
   d. Banded joints
   e. Smooth mil finish
4. Aluminum Jacket Fitting Covers
   a. Same material, finish, and thickness as jacket
   b. Preformed 2-piece or gore elbows
   c. Tee covers
   d. Flange and union covers

e. End caps
f. Beveled collars
g. Valve covers.

G. Insulation Supports and Shields

1. Non-Crush Insulated Pipe Support

a. Pipe support to prevent condensation and insulation damage at fixing / support points
b. Thermally non-interacting mounting aid for elastomeric tube insulation
c. Approximate compressive strength: 220 psi
d. Approximate density: 6-7 lbs/ft^3

2. Pipe Shield

a. Galvanized Steel
b. Composite Plastic

1) Similar to Armacell Insuguard

2.2 TANK, VESSELS, & EQUIPMENT

A. Fiberglass Insulation

1. Glass fibers bonded with a bio-based thermosetting resin
2. Thermal insulation blanket
3. Compliances:

a. ASTM C1139, Type I Grade 2, Type II Grade 2
b. ASTM C553 TypeI, II, V
c. ASTM C411
d. NFPA 90A and 90B,
e. UL Environment GREENGUARD, Gold certified
f. UL Validated formaldehyde-free,
g. UL Validated for recycled glass content of 50% minimum
h. Bio-soluble certified by EUCEB
i. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.

4. Performance Requirements:

a. Maximum service temperature of 1,000°F.
b. Thermal conductivity (k-value) at 200°F mean temperature shall be 0.38 Btu x in. /h x sq. ft. x °F, or less.

5. Acceptable Products:

a. Knauf Insulation: Elevated Temperature Blanket 1000°F with ECOSE.
b. Others by listed manufacturers meeting physical and performance properties:

1) CertainTeed
2) Johns Manville
3) Owens Corning
4) Manson Insulation

B. Fiberglass Pipe Insulation – Segmented, Semi-Rigid:

1. Glass fibers bonded with a bio-based thermosetting resin
2. Semi-rigid, segmented board in roll form with glass fibers adhered perpendicular to the vapor retarder facing
3. Compliances:

a. ASTM C1393, Category 1.

b. Compressive strength per ASTM C165, not less than 120 PSF at 10% deformation
c. Must be NFPA 90A and 90B compliant,
d. UL Environment GREENGUARD Gold certified
e. UL Validated Formaldehyde-free
f. UL Validated for Recycled Glass Content of 50% minimum
g. Bio-soluble certified by EUCEB.
h. Maximum Flame spread rating of 25 and Smoke developed rating of 50 when tested in accordance with ASTM E84 or UL 723.

4. Performance Requirements:

a. Maximum service temperature of 850 degrees F.
b. Thermal conductivity (k-value) at 100 degrees F mean temperature shall be 0.26 Btu x in. /h x sq. ft. x degrees F, or less.

5. Provide insulation with factory-applied vapor retarder facing complying with ASTM C1136.
6. Acceptable Products:

a. Knauf Insulation; Earthwool Pipe & Tank Insulation with ECOSE.
b. Manson Insulation; Earthwool Pipe & Tank Insulation with ECOSE
c. Others by listed manufacturers meeting physical and performance properties:

1) CertainTeed
2) Johns Manville
3) Owens Corning.

C. Elastomeric Insulation

1. Black flexible closed-cell elastomeric thermal insulation in sheet and roll form
2. Compliances:

a. ASTM E84, UL723
b. NFPA 90A, 90B
c. UL Environment GREENGUARD Gold certified
d. UL Validated formaldehyde free

3. Performance Requirements:

a. Maximum Use Temperature: 200°F
b. Thermal conductivity (k-value) at 100°F mean temperature: 0.27 Btu x in. /h x sq. ft x degree F, or less.

4. Acceptable Products:

a. Armacell: AP ArmaFlex
b. Others by listed manufacturers meeting physical and performance properties:

1) Aeroflex
2) K-Flex

D. Mastics, Coatings, Sealants, & Adhesives

E. Protective Covers.

2.3 DUCTWORK INSULATION

A. Duct Wrap Insulation

1. Flexible glass fiber blanket-type insulation with vapor retarder jacket for use in insulating the exterior of metal ductwork.
2. Density: not less than ¾ lb/ft^3
3. Factory-applied flame-retardant vapor barrier facing

4. 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 adhesive.
5. Water vapor permeance: no greater than 0.02 perms
6. Flame spread: 25 or less
7. Smoke developed rating: 50 or less
8. UL Listed as Plenum Rated for installation in plenums.
9. Manufacturer shall be as listed in the Quality Assurance paragraph above.
10. Acceptable Products:

    a. Knauf Insulation Performance Duct Wrap with ECOSE
    b. Manson Insulation Alley Wrap B Duct Wrap with ECOSE
    c. Others by listed manufacturers meeting physical and performance properties

B. Duct Liner Insulation

1. Flexible glass fiber blanket-type insulation with black bonded mat airstream side finish for use in insulating the interior side of metal ductwork.
2. Meet NFPA-90A and 90B
3. Tested by UL 723
4. Density: not less than 1.5 lb/ft^3
5. K-value: 0.28 at a mean temperature of 75°F.
6. Flame spread: 25 or less
7. Smoke developed rating: 50 or less
8. Suitable for velocities up to 6,000 fpm.
9. Manufacturer shall be as listed in the Quality Assurance paragraph above.
10. Acceptable Products

    a. Knauf Insulation Performance+ Duct Liner with ECOSE
    b. Manson Insulation Akousti-Liner with ECOSE
    c. Others by listed manufacturers meeting physical and performance properties

C. Mastics, Coatings, Sealants, Adhesives, Cements.

1. Materials shall be compatible with insulation materials and substrates and for bonding insulation to itself and to surfaces to be insulated unless noted otherwise.
2. Refer to Quality Assurance paragraph for acceptable manufacturers.

D. Fire-Rated Duct Wrap

1. Flexible or board type fire rated duct enclosure system on metal ductwork and portions of hoods.
2. The ductwrap, or board, shall be a noncombustible fire-proofing material capable of withstanding temperatures in excess of 2,000°F and up to 1,800°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. 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.
4. Board density shall be a nominal 18 pounds per cubic foot or greater.
5. The R-value shall be approximately 1.7 per inch thickness of the board material.
6. Flexible ductwrap 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.
7. Flexible duct enclosure systems shall meet all pertinent requirements of the most recent versions of ASTM E2336 and NFPA 96 (Section 4.3.1).
8. This requires a two inch (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.
9. Fire-Rated Duct Wrap materials shall be as manufactured by:

    a. 3M Corporation or equals by;
    b. Morgan Advanced Materials Thermal Ceramics Firemaster, or
    c. Alkegen / FyreWrap by “Unifrax”.

E. Aluminum Jacketing

1. Aluminum jacketing / cladding
2. Locked seams
3. Banded joints
4. Conforms to ASTM B-209
5. Conforms to ASTM C1729
6. Min. 0.016” thick
7. Smooth mill finish
8. Equivalent to Johns Manville aluminum jacketing or RPR aluminum jacketing.

PART 3 - EXECUTION

3.1 GENERAL

A. Apply insulation and covering after all of the distribution system to be insulated has been pressure tested, found to be completely tight (without leaks), and accepted as such. All insulated accessories and caps should be installed prior to commencing with insulation. Verify that control, isolation, and balancing valves and any other piping or duct specialty where a valve stem or test port extends beyond the normal insulation thickness to be installed is installed pointed upward vertically. Thoroughly clean and dry all surfaces prior to being covered.

B. Where jacketing systems are specified, install. 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. Secure or adhere the jacketing, as appropriate for the application. Where adhesives are used, follow approved methods by manufacturer for installation. Adhesives shall have mold and mildew inhibitors.

C. 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.

D. 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

Where pipe or duct insulation is installed in plenums, they shall be listed and labeled.

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

F. 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.

G. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any materials damaged by condensation.

H. Hanger and Support Locations:

1. See requirements regarding shields and inserts which follows.

2. At the location of hangers or supports for pipes run above ground and finished with a vapor seal insulation, provide rigid sections of calcium silicate or high density polyurethane (or a product similar to Armacell ArmaFix EcoLight), 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.
3. Hangers and supports for piping insulation to receive a vapor barrier shall be installed exterior to the insulation.

I. The following describes materials, thickness and finishes for insulation. 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.

J. 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 C1338, shall be rated as not promoting growth of fungi and bacteria. Inhibitors shall be added to specified products to meet these requirements.

3.2 PIPING INSULATION

A. Pressurized Hydronic Lines (Chilled Water and Heating Water):

1. Provide pre-formed fiberglass pipe insulation with factory applied, white ASJ+ or ASJ, fire resistant, vapor barrier jacket.
2. Use the SSL or SSL+ adhesive closure system on the ASJ or ASJ+ jacket longitudinal seam to secure pipe insulation to the pipe. Do not use outward clinching staples for closure of the vapor retarder jacket.
3. Insulation thickness shall at a minimum, satisfy the energy code governing the project and the following table.

PIPING SYSTEMS	INSULATION THICKNESS - INCHES P I P E S I Z E S					
	RUNOUTS* 3/4" & SMALLER	< 1"	1" TO 1-1/2"	1-1/2" TO 4"	4" TO 8"	8" and OVER
Heating Water (105-200°F)	1.50	1.50	1.50	2.00	2.00	2.00
Chilled Water (40-60°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.

4. Insulate valves and fittings with pre-molded fiberglass pipe insulation with ASJ.
5. If pre-molded fitting insulation is not available for welded pipe fittings, field fabricated, mitered segments of straight pipe insulation without ASJ equal in density to adjoining pipe may be used.
6. If pre-molded fitting insulation is not available for screwed, soldered, or brazed pipe fittings, then field fabricated insulation may be wrapped, compressed tight, equal in thickness and density to adjoining straight pipe insulation.

7. Vapor seal with 1/8” thick wet coat of sealant or approved equivalent vapor barrier coating placed over 10 x 10 strands per square inch glass fabric mesh which shall have a vapor retarder mastic embedded in it when applied. Apply a second of coating of 1/8" thick sealant 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.
8. Apply PVC jacketing over pipe, valves, and fittings where exposed from the finished floor up to 12’-0”AFF, including all portions of horizontal piping that occurs and extends above this elevation
    a. Jacketing shall be applied to all straight piping segments.
    b. Jacketing shall be applied to pipe fittings and accessories — elbows, tees, valves, flanges, fittings, etc.
    c. Seal all jacketing seams with tape or other approved means, along the length and butt joints of the jacketing seams.
    d. Jacketing shall be white in color unless noted otherwise.
    e. Loose “diaper” inserts at fittings shall not be permitted.
9. Pipes in mechanical equipment rooms may be covered with 0.016” aluminum jacketing from the finished floor to 8’-0”AFF in lieu of PVC jacketing for the same elevation range. Jacketing shall cover straight runs of piping and fittings/specialties (elbows, tees, valves, etc.).

B. HVAC Piping exposed outside a building envelope (Chilled Water, Drain, Chemical Treatment, and Filtration Systems):

1. Protect to -10°F by wrapping pipe system with heat tracing. Refer to Section 23 05 33 – Heat Tracing for HVAC Piping for further details.
2. Insulate pipe system with 2” thick, 4 lb or heavier density, molded fiber glass insulation and cover with FRJ jacket.
3. Insulate fittings the same as described for interior pipe systems of the same type.
4. Cover with 0.016” aluminum jacket with locked seams and banded joints, made watertight.
5. Cover valves, couplings, and other fittings with prefabricated aluminum jacket fitting covers. Factory applied moisture barrier shall be applied to match thickness used on straight piping.
6. Seal ends to prevent moisture penetration and make weatherproof.

C. Drain, Refrigerant, and Miscellaneous Lines:

1. The drain lines as well as all refrigerant suction piping shall be insulated with closed-cell elastomeric thermal insulation in tubular form.
2. Insulation shall be continuous from the drain connection at the equipment to the point of discharge open sight air gap over a drain.
3. Provide 0.5" thick insulation on condensate drains.
4. Provide 1.5" thick insulation on refrigerant suction piping.
5. For all closed-cell elastomeric thermal insulation in tube form that is installed outdoors:
    a. Insulate as described above.
    b. Provide aluminum jacketing on insulated pipe.
    c. Provide jacketing on insulated fittings.
        1) Cover mechanical couplings and fittings with prefabricated aluminum jacketed fitting covers with factory applied moisture barriers to thickness to match that on piping.
        2) Band in place.
        3) Seal ends to prevent moisture penetration and to make completely waterproof.

D. 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°F and have a melting point of no lower than 3,100°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 approved manufacturers listed in the Quality Assurance paragraph.

E. 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.

F. 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.

G. SHIELDS AND INSERTS

1. Metal saddles / pipe 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 may be made of plastic similar to the Armacell Insuguard or it may be made of galvanized sheet metal. The shield and shall be of sufficient size and length to prohibit the crushing of the insulation materials.
2. Metal 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"

3. An insert shall be provided to prevent the crushing of the insulation by the shield and hanger while also maintaining the thermal barrier.
   a. This may be similar to Armacell ArmaFix EcoLight.
   b. This may be calcium silicate for heating water pipe systems.
   c. This may be cellular glass or 7 lb / ft^3 fiberglass pipe insulation for chilled water pipe systems.
   d. 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.
   e. 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"

3.3 TANK, VESSELS, & EQUIPMENT

A. Piping Specialties / Appurtenances

1. Piping specialties and appurtenances include the following.

   a. Air separators
   b. Compression / Expansion Tanks
   c. Storage Tanks
   d. Buffer Tanks

2. Insulate piping specialties and appurtenances with 2” thick fiberglass insulation of either the pre-formed or segmented, semi-rigid type (that is, fiberglass pipe and tank insulation).
3. Cut and fit insulation to fit the contours of the appurtenances / equipment.
4. Protect ASME / equipment labels from physical damage and from being covered with mastic and insulation. Bevel insulation around labels and seal exposed cut insulation with mastic. Provide a ½” thick removal patch for the label. The patch shall be elastomeric insulation.
5. Finish with PVC sheet jacketing.

B. Pumps

1. Insulate pumps with 2” thick elastomeric insulation.
2. Cut insulation to fit the contours of the equipment.
3. Secure insulation and provide a vapor barrier.
4. Insulation boxes on pumps shall allow accessibility to the pumps, that is, provide multiple pieces as needed to allow removal of pieces without damaging insulation.
5. Fill voids with packaged fibrous insulation to eliminate air pockets.

3.4 DUCTWORK

A. Duct Insulation - External:

1. Concealed (above ceilings) external duct insulation shall be fiberglass blanket-type insulation.
2. All insulation systems shall meet the most recently approved 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. Externally insulate all rectangular and round supply air and return air ducts not internally lined. Provide a minimum overlap of 12” where insulation transitions from internal liner to external wrap.
4. Kitchen make-up air ducts shall not contain internal lining and shall always be externally insulated.
5. Insulate the outside of all fire, fire-smoke, and smoke damper sleeves penetrating walls and floors to ensure a continuous insulation system.
6. External insulation shall be applied in accordance with the manufacturer's recommendations. Rigid insulation and duct wrap installed on wide ductwork shall be installed by impaling over pins using speed clips or be secured with an approved adhesive. Where used, pins shall be spaced 12" on center both ways.
7. Seal all joints, breaks, fastener penetrations and punctures with a 3" wide vapor barrier strip similar to that of facing materials.
8. Vapor seal all jacketing penetrations, cut openings, and cut edges with an approved vapor barrier coating.

B. Duct Insulation - Internal:

1. Internal duct insulation, liner, shall be in thicknesses as indicated herein.

2. 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.
3. 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.
4. All insulation systems shall meet the most recently approved 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.
5. Duct Insulation - Internal: Provide sound absorbing and thermal insulation to the interior surface of the duct systems noted in the following list:

Rectangular Low Pressure Supply Air Ductwork (within 10’-0” from fans or as noted elsewhere on drawings)
Rectangular Low Pressure Return Air Ductwork (within 10’-0” from fans or as noted elsewhere on drawings)
Rectangular Low Pressure Relief / Exhaust Air Ductwork (within 10’-0” from fans or as noted elsewhere on drawings)
Rectangular Outside Air Ductwork (within 10’-0” from fans or as noted elsewhere on drawings)
Supply Air, Mixed Air, and Return Air Plenums
General Exhaust Air (only within 10’-0” of the fan; NOT Fume, NOT Chemical, NOT Grease, NOR other such hazardous air classifications)

C. Fire Rated Duct Wrap / Boards for Grease and Fume Exhaust Ductwork and top of hoods (only where not addressed by the hood manufacturers) exposed above ceilings:

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.
2. 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.
3. Refer to Specification Section 23 31 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. 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 two inch (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.

D. Aluminum Jacketing

1. Insulate ductwork routed in outdoor environments or crawl spaces or as noted on drawings and as specified for insulation.
2. Cover external duct insulation in these environments with aluminum jacketing characterized by locked seams and banded joints made water tight.
3. Overlap joints and segments of jacketing.
4. Seal seams to prevent moisture penetration and to make completely weatherproof.
5. Jacketing shall increase in thickness with the increase of the duct + insulation size per the requirements of ASTM C1729.

END OF SECTION

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SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 01 - 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 mechanical and service water-heating systems including but not limited to the following.

1. Service water heating systems
2. All related controls for these systems
3. Pumps
4. Exhaust fans
5. Boilers
6. Chillers
7. Cooling Towers
8. Air handling units
9. Packaged rooftop A/C units
10. Unit heaters

C. Commissioning requires the participation of Division 22, 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.

E. The participating subcontractors should include all time and services necessary to fulfill the requirements outlined in this section of specifications.

F. Commissioning work in this specification is intended to meet the requirements as outlined in the energy compliance path, for all systems listed therein.

1.3 COMMISSIONING AUTHORITY

The commissioning authority or agency shall be selected and employed by the building owner. 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 is mandatory. The commissioning agent shall not be associated with or employed by a mechanical contractor, or equipment supplier.

1.4 COMMISSIONING PLAN

A. 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*.

B. 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 such as the following:

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 the normal submittal process, which should include detailed start-up procedures.
4. The CA works with the pertinent subcontractors in developing startup plans and startup documentation formats, including pre-functional checklists to be completed, during the startup process by the installing contractor.
5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with pre-functional checklists being completed before functional testing.
6. Subcontractors, under their own direction, execute and document the pre-functional 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. 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.

1.5 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:

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 pre-functional 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 pre-functional 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:

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 the TAB firm.
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):

The commissioning responsibilities of the controls contractor, during construction and acceptance phases in addition to those listed previously 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, set points 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 set point (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 Set point: Point that controls equipment and can have its set point 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 firm any needed unique instruments for setting terminal unit boxes and instruct TAB firm in their use (hand held 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 based on 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 previously 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. Review of 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 set point 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 The Associated Air Balance Council (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 subcontractors.
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 design team. 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 update timelines and schedules and provide technical expertise as needed.

b. Coordinate the commissioning work and, with the GC, ensure that commissioning activities are being scheduled into the master project construction schedule.
c. Revise, as necessary, the Commissioning Plan from the start of the project to the end of the 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 design team reviews.
h. Assist in the development of pre-functional 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 owners 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 pre-functional tests and checklist completion by reviewing pre-functional 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.

1.6 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 project 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 the *Specifications.* 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. Pre-functional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record 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 subcontractors 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 design team 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, PRE-FUNCTIONAL 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 pre-functiontional checklists and startup.

B. Pre-functional 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 pre-functional checkout. No sampling strategies are used. The pre-functional 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 pre-functional 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. Pre-functional 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 pre-functional 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 (+/-)
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 Pre-functional 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 pre-functional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off pre-functional 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 pre-functional 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 pre-functional tests and checklists.
5. Only individuals that have direct knowledge and witnessed that a line item task on the pre-functional 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 pre-functional 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 55°F, when the outside air temperature is above 55°F, temporarily change the lockout setpoint to be 2°F 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 pre-functional 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 pre-functional 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 responds with their intentions to correct 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 made in consultation with the design team. 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 pre-functional 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 the completion of System and O&M manual requirements as specified herein do not replace O&M manual documentation requirements specified 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 and 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. This may be shared electronically or physically as three copies in labeled 3-ring binders with indexed tabs:

1. 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 design team and the CA.

3.8 TRAINING OF OWNER PERSONNEL

A. GC shall be responsible for training coordination and scheduling and ultimately to ensure that all required 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 at least two (2) weeks before the planned training is scheduled to occur.
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,* the most recent version, 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
1	Pumps
1	HVAC Fans
1	ATUs
2	Boilers
2	Chiller
2	AHUs
2	Roof Top Units
1	Split D/X Systems
1	Unit Heaters

D. Controls Contractor shall have the following training responsibilities:

1. Provide the CA with a training plan a minimum of four (4) weeks before the planned training is scheduled to occur.
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 four (4) 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 four (4) 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 four (4) 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 4 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

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SECTION 23 09 00

CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

B. Comply with Section 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 an Energy/Building Management System with direct digital control (DDC). The system shall include 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 and 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 monitored and controlled remotely via a web browser. The entire system of control and automation at this building shall thus become an integral part of the facilities' Energy Management System (EMS).

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 CPU 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 one of the following.

1. Enviromatic Systems (Reliable Controls)
2. Johnson Controls (Metasys)
3. Schneider Electric
4. Siemens (Apogee)
5. JMS Integrated Building Solutions (Distech 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.

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 ensure 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 eight (8) hours for the basic Controls System and eight (8) 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. System Integrator Qualifications:

1. The system integrator (SI) must be regularly engaged in the service and installation of BACnet MS/TP controls as specified herein. The SI shall have a minimum of 10 years' experience in the sales, installation, engineering, programming servicing and commissioning of BAS Systems.
2. The system integrator must be an authorized factory direct representative in good standing of the manufacturer of the proposed hardware and software components.

3. The SI shall have an office within 50 miles of the building site that is staffed with a minimum of 4 technicians who have successfully completed the factory authorized training of the proposed manufacturers hardware and software components. The SI capabilities shall include engineering and design of control systems, programming, electrical installation of control systems, troubling shooting and service.
4. The SI must be able to submit list of no less than three (3) similar projects, which have similar Building Automation Systems as specified herein installed by the SI. These projects must be on-line and functional such that the Owner's/user's representative can observe the system in full operation if requested.

I. Hardware and Software Component Manufacturer Qualifications:

1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of BACnet based systems as specified herein, and must have been so for a minimum of two (2) years.
2. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll-free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
3. Acceptable manufacturers of the hardware and software components as specified herein are as follows:

   a. Reliable Controls
   b. Johnson Controls Metasys
   c. Distech Controls
   d. Schneider Electric
   e. Siemens Apogee

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, General Provisions.

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.
3. Three (3) copies of all Spare Parts Lists and Product Data.
4. Three (3) CD's of the above information in .PDF Format to include product data and related Operations and Maintenance Data.

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 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 MANUAL ACTUATORS AND OPERATORS

A. PUSH BUTTON SWITCHES

1. The push button switch for activation of the storm shelter ventilation system and protection systems shall be equal to Safety Technology International (STI) Stopper Station Model SS2329ZA-EN.
    a. White color
    b. Red push button, turn to reset
    c. LED status indicator, turns green when activated
    d. Protective transparent lift cover
    e. Provide necessary options for a full and complete installation appropriate for the application.
    f. Custom label on device in English.
    g. Further details as noted on drawings
2. The push button switch for activation purge exhaust fans shall be equal to Safety Technology International (STI) Stopper Station Model SS2529ZA-EN.
    a. Orange color
    b. Red push button, turn to reset
    c. LED status indicator, turns green when activated
    d. Protective transparent lift cover
    e. Provide necessary options for a full and complete installation appropriate for the application.
    f. Custom label on device in English indicating function of switch: "PUSH TO ACTIVATE EXHAUST FAN".
3. Other wall switches of toggle type shall be industrial grade and rated for the application, similar to Leviton Type 1221. Refer to drawings and other parts of the specifications for application of these devices. Provide aluminum or stainless-steel cover plate.

2.2 TEMPERATURE SENSORS

A. General Requirements

1. Temperature sensors shall be of the type and performance level as indicated and/or required for the application intended.
2. Temperature sensors shall permit accuracy rating of ± 0.5% of the temperature range intended for their use, unless noted otherwise below.
3. Temperature sensors shall be nickel wire thermistor, 10,000 or 30,000 ohm resistance, or RTD Type, with 1000 ohms resistance at 70 Deg.F., and a 3 ohms/per degree F temperature coefficient.
4. Sensors in the building environment shall operate in a stable manner in a 5-95% relative humidity, non-condensing environment.
5. Ambient temperature limits shall be minimum of 0-125 Deg.F. with a +/- 0.5% accuracy of nominal resistance at 70 Deg.F.
6. Furnish sensors with maximum 6-to-9-inch insulated pigtail leads or trim as required.
7. All sensor actions shall be the same for the entire building.

B. Outdoor Air Temperature Sensors

1. Air temperature sensors to be used for measuring outdoor air temperatures shall be designed and rated for outdoor mounting and use. Mounting type shall be appropriate for the mounting option intended.
2. The temperature sensor shall have a minimum range of -52°F to 152°F.
3. The temperature sensor shall have an accuracy of ± 1°F in the specified temperature range.
4. Acceptable Manufacturers:
    a. Reliable
    b. Veris

C. Space Wall Mounted Air Temperature Sensors

1. Space wall mounted sensors shall be installed 48” inches above finished floor to comply with ADA, unless indicated or approved otherwise by the Architect, Owner, or Owner’s Representative.
2. Space wall mounted air temperature sensors for normally occupied spaces shall include the following accessories, features, and functions.
    a. No display
    b. No setpoint adjustment using up/down buttons on a slider
    c. No momentary local override pushbutton
    d. No jack allowing access to the host controller’s BACnet MS/TP network
3. Space wall mounted air temperature sensors shall have an accuracy of ± 0.36°F in the range of 32°F to 96°F.
4. For sensors located in environments or areas of potential impact, provide an impact resistant metal wire cage.
5. Where wall mounted temperature sensors are to be installed in spaces also requiring wall mounted relative humidity or carbon dioxide sensors, combination sensors may be provided.
6. Acceptable Manufacturers:
    a. Reliable
    b. Johnson Controls
    c. Distech
    d. Schneider Electric.
    e. Automation Components Inc. (ACI)
    f. Veris

D. Duct Mounted Air Temperature Sensors

1. Duct Mounted Air Temperature Sensor — Probe Type

a. Duct mounted air temperature sensors shall be provided with 304 Stainless Steel probe of a length not less than ¼ the length of the duct in the installed direction.
b. Duct mounted air temperature sensors shall have an accuracy of ± 0.36°F in the rage of 32°F to 120°F.
c. The sensor's transmitter shall be located on the outside of the duct and insulated in an enclosure.

2. Duct Mounted Air Temperature Sensor — Averaging Capillary Type

a. Average capillary type duct mounted air temperature sensors shall measure air temperature in ductwork across the full width of the duct.
b. Minimum sensor length shall be 15 feet, but Contractor shall select sensors with lengths that provide full coverage across each duct they are installed in.
c. Adequate supports for the element within the duct shall be provided/included. Where installed near coils, maintain a minimum one-inch (1") separation from the coil.
d. Install per manufacturer's recommendations.
e. The capillary shall be copper and provided with a non-conductive protective sheathing to prevent contact with all obstructions near the capillary to prevent "rub-outs."
f. The accuracy of the sensor shall be ± 1°F.

E. Hydronic Systems Water Temperature Sensors

1. Water temperature probe type sensors

a. Water temperature probe type sensors for such systems as chilled water systems shall be 304 Stainless Steel immersion probe type sensors.
b. The sensor accuracy shall be ± 0.25% in their range of application.
c. For pipe application, the probe length shall be between 1/3 to ½ of the pipe diameter.
d. For tank application, the probe length shall be a minimum 18".

2. Thermowells

a. Thermowells shall be machined 304 Stainless Steel or machined brass.
b. The diameter of the wells shall allow for easy fit of sensors and shall have a minimum ½" internal threads and ¾" external threads.
c. Wells shall be equal to MAMAC A-500.

F. Heat conductive paste shall be provided for the placement of sensors in the thermowells. Thermal compound shall be equal to MAMAC A-505.

2.3 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 be 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.

E. Provide duct or remote mount probes as required for the application.

F. 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.

G. Acceptable Manufacturers:

1. Reliable Controls
2. Distech
3. Schneider Electric
4. Automation Components, Inc
5. Veris

2.4 CARBON MONOXIDE SENSORS

A. Provide a complete carbon monoxide detection and alarm system as described per Section 915 of the applicable International Building Code and Section 915 of the International Fire Code. Provide a complete system as described herein.

B. Detection and Alarm Systems shall be installed to protect spaces with gas fired appliances.

C. Detection and Alarm Systems shall serve the spaces identified herein only where served by fuel burning (natural gas) forced air furnaces which includes rooftop A/C units and spaces containing fuel burning (natural gas) appliances such as gas-fired water heaters.

D. Detection devices shall generally be centrally located in the ceilings of the spaces served.

E. Alarm system shall include a local alert and transmission of an alarm condition back to a central location where administrative staff (school personnel) will easily identify an alarm condition.

F. Local alarms may have a local silence button which shall only override the audible alarm for a short period of time after which it shall become audible again. If the alarm is silenced more than three (3) times this feature shall be disabled and the audible alarm shall continue until the carbon monoxide level of concern drops below alarm level activation.

G. Detection devices shall be powered by the control transformers serving the respective fuel burning forced air furnace. Alternately the contractor may use spare 120 volt, 1 phase power circuits which may then serve stand alone 120 volt to 24 volt transformers (or whatever low voltage is compatible with the detectors).

H. All detection and alarm devices shall include a long life, minimum five (5) years, Ni-Cad rechargeable battery which shall be a back-up power source for the equipment should the normal power source fail.

I. Contractor shall include installation of all materials, preparation of submittals/shop drawings, installation of detectors/alarms, installation of power supply, interlock and alarm signal conduit/wiring and installation of related programming to result in a complete and operational system. Plenum rated low voltage signal wiring may be used in lieu of wiring in conduits where applicable, to be neatly routed and supported.

J. Where multiple rooms are served by a single fuel burning forced air furnace locate the detector near the first air device closest to the air supply source of the unit.

K. All detectors shall include “test” buttons, a red LED/Diode light to indicate a fault, malfunction or alarm condition and a green LED/Diode light to indicate normal operation without an alarm.

L. All detectors shall be able to detect carbon monoxide from 5-100 Parts per Million (PPM). Alarm detection levels shall be individually adjustable on each detector but shall be initially set to generate an alarm upon the detected carbon monoxide level rising above 20 PPM.

M. The accuracy of the sensors shall be plus or minus 2 PPM, or ± 3%.

N. Carbon monoxide detection systems shall comply with NFPA 720 with detectors being listed in accordance with UL 2075.

O. Carbon monoxide alarm systems shall be listed in accordance with UL 2034.

P. Detection device covers shall be a neutral color (beige or off white) and be impact resistant. Size shall be approximately 5” wide x 4” high by 1.75” deep.

Q. Include audible horn and alarm relays with each detection device. Horn shall generate a sound level of 85 dB at 10 feet.

R. All detectors shall have a minimum warranty of five (5) years.

S. Carbon Monoxide Sensors in Classroom Spaces

1. Coordinate with Fire Alarm, Division 28 work. If device is to integrate with the fire alarm system it shall be provided by Division 28.
2. Acceptable manufacturers:
    a. Gentex Model C01209 Series A/C powered plug-in or hard wired with battery backup electrochemical carbon monoxide sensor with alarm.
    b. Others that are equal.

T. Carbon Monoxide Sensors in Boiler Rooms or Mechanical Rooms

1. Coordinate with Plumbing, Division 22 work. If device is to monitor CO from a Division 22 provided gas water heater, the sensor shall be provided by Division 22.
2. 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 building automation system 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.
3. Acceptable manufacturers:
    a. Greystone Energy Systems, Inc. model CMD5B
    b. Nova
    c. Air Products
    d. Honeywell
    e. Kele
    f. Gas Lab
    g. American Gas Safety (AGS)
    h. Macurco

2.5 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 ± 30 ppm with ±5% of measured reading, 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, ± 75 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. Provide a 5-year manufacturer’s warranty.

H. Sensors shall be as manufactured by:

1. Reliable Controls
2. Schneider Electric
3. Automation Components, Inc
4. Veris Industries, Model CWL-S-H-T-J or,
5. Vaisala, Model GMD/W20, or.
6. Tel-Aire, Models 8101/8102.
7. American Gas Safety (AGS)
8. Macurco
9. Senva

2.6 REFRIGERANT GAS DETECTION SYSTEM

A. Description

1. Provide a complete installation of a refrigerant gas detection system and automatic means of ventilating the space during a leak condition.
2. The system shall include, but not be limited to, the following:
    a. Central Control Panel
    b. Remote Refrigerant Detectors
    c. Remote Audible and Visual Alarm Beacons
    d. Emergency Push Button Switch

B. Products

1. Control Panel
    a. Locate in chiller room at 48” A.F.F.
    b. Provide manual reset button on front to reset alarm condition.
    c. Clear screen display shall show sensors, target gases, and PPM readings.
    d. Provide integral 24Vdc power output and Modbus for remote sensors.
    e. Provide capability to communicate pre-alarm and high-alarm conditions to BAS/EMS/BMS.
    f. Provide button on front to actuate ventilation system.
    g. Operational environment
        1) Humidity: 5-95% RH non-condensing
        2) Temperature: -4°F-140°F
    h. Fan relays
    i. Accepts up to eight remote detectors
    j. Integral audible and visual alarms capable of 85 dBA at 10 ft.
    k. Provides 24Vdc output to activate remote audible and alarm beacons with in-built adaptable tones and strobes.
    l. Mute Function to silence all integral buzzers and connected audible/visual alarms
2. Refrigerant Detectors
    a. The detector shall utilize a non-dispersive infrared type (NDIR) with a minimum accuracy of +/- 5% FS range below 50% F.S. and +/- 7% of FS range above 50% full scale.
    b. Detectors shall be of the diffusion type.
    c. Modbus communication and 24Vdc power supply.
    d. Factory set high alarm levels to the corresponding ASHRAE OEL value.
    e. Pre-alarm levels shall be factory set to the specifications in this document.
    f. The detectors shall be capable of sensing for the type of refrigerant specified in the chiller equipment and shall come factory calibrated. Coordinate with chiller selections for exact refrigerant type(s).
    g. Provide one detection point per chiller.
3. Remote Audible and Visual Alarm Strobes

a. Locate outside of each exit, and as shown on drawings.
b. 24Vdc Power Supply
c. Minimum of 85dBA at 1ft
d. Visual strobe
e. Adjustable strobe and sound settings

4. Emergency Push Button Switch

a. Yellow color
b. Red push button
c. LED status indicator, turns green when activated (whether by pushing or automatically by system)
d. Protective transparent lift cover / shield
e. Provide necessary options for a full and complete installation appropriate for the application.
f. Custom label on device in English: EMERGENCY GAS SHUT OFF
g. Further details as noted on drawings.

2.7 COMBINATION SENSORS

A. Where space temperature, relative humidity and/or carbon dioxide sensors are all designated to be located in the same location for control or monitoring purposes combination sensors are desired such that one wall mounted device and single back box is required.

B. Where combination sensors are required the specified levels of accuracy will be required. The use of combination sensors does not relieve these requirements.

2.8 ROOM SENSOR AND THERMOSTAT PROTECTIVE COVERS

A. Provide opaque Lexan thermostat guards with adequate vent openings for measuring air properties, mounting brackets, and tamper proof screws for each wall mounted thermostat and sensor installed in public use areas, unless indicated otherwise. Administrative office areas and classrooms shall not require guards. Generally, these guards shall only be provided in Institutional Public Use Areas such as Public Use Corridors, Library, Cafeteria, and other large assembly type areas.

B. Provide painted metal, steel, cast aluminum, or cast-iron guards, in high abuse areas such as Gymnasiums, Locker Rooms, Free Weights and Circuit Training without exception.

C. Guards shall be sized to accommodate the thermostat or sensor to be enclosed, and include ventilation openings, ring base, and key lock.

D. Guards shall be as manufactured by:

1. Mason.
2. Honeywell.
3. Best Engineered Control Products.

2.9 OUTDOOR WEATHER STATION

A. An outdoor weather station shall be provided as needed with an outdoor rated enclosure with solar shield.

B. Weather station temperature sensor shall be as specified previously in this section.

C. Weather station humidity sensor shall have an accuracy of ± 2% in the range of 0-100% RH.

D. The weather station shall directly calculate dew point.

E. The weather station shall be provided with a 3-cup anemometer for measuring wind speed with an accuracy of ± 5% for wind speeds up to 100 mph.

F. The weather station shall be provided with wind vane providing 360° wind direction.

G. The weather station shall communicate with the BAS.

2.10 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°F up to 65°F Standard setpoint shall be 40°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 contact. Provide an additional set of dry contacts on each device for connection to a central control and monitoring system (BAS).

D. Sensor and controller shall be able to operate in ambient conditions from 20°F to 104°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:

1. Johnson Controls
2. Honeywell
3. Siemens.

2.11 SMOKE DETECTORS

A. One (1) smoke detector shall be furnished and installed under Division 26 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 ensure sampling tubes are provided suitable to the width of duct in which installed.

C. Detectors shall be supplied with 120 volts, or 24 volts, power supply under Division 26. Control circuit integration wiring shall be under this section of specifications.

D. Acceptable duct detectors, where not specified elsewhere, shall be THORN-DH-22, BRK-DH2851AC, or Gamewell MS-69433, suitable for single station operation.

2.12 AIR PRESSURE SENSORS

A. General

1. Pressure sensors shall be temperature compensated and shall vary the output voltage with a change in differential pressure.
2. The sensing range of the sensor shall be suitable to the application, with linearity of 1.5% of full scale and an offset less than 1% of full scale.
3. The sensor shall be capable of operating in pressures up to 150% beyond the sensing range without damage.

B. Duct Pressure Sensor

1. Provide duct pressure sensors as required in the sequences of operation specified.
2. Provide appropriate mounting brackets and any remove mounting probe kits as necessary for each particular mounting condition.

C. Space Pressure Sensor

1. Provide space pressure sensors as required in the sequences of operation specified.
2. The accuracy of space pressure sensors shall be ±0.01 inches water gauge within the sensing range of the device.

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. Sensors shall be equal to Setra Model C-280E Series designed for electrical connection to a two-wire circuit by simple screw termination.

E. 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).

F. Sensors shall be temperature compensated for low ambient thermal error.

G. Sensor accuracy shall be 0.11% of full scale at constant temperature.

H. 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

2.14 DIFFERENTIAL WATER PRESSURE SENSORS (TRANSDUCERS)

A. Differential Water Pressure Sensors (Transducers) shall be provided where indicated and as required to affect 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. Senva.

2.15 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 water-cooled condensers for heat pumps, 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. Set point 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 2113.

I. Acceptable manufacturers:

1. Johnson Controls, Inc.

2. Honeywell, Inc.
3. Invensys
4. Siemens.
5. Robertshaw
6. McDonnell & Miller
7. Dwyer.

2.16 WATER LEVEL SENSORS

A. Where water level sensors are not provided by equipment manufacturers (the Controls Contractor shall coordinate with the Mechanical Contractor to determine which equipment manufacturers are provided these sensors), provide a float switch for detecting condensate overflow in the drain pans of packaged unitary and split direct expansion air conditioners.

B. The float switch shall detect excess condensate water in the drain pan and send an alarm signal to the building management system.

2.17 WATER FLOW METER

A. Furnish and install water flow meters where indicated on the drawings.

B. Meters shall be the inline insertion electromagnetic type flow meter.

C. Acceptable Products:

1. Onicon Model FB-3500 Series, bi-directional flow meters
2. Similar or equal products by Data Industrial will be considered

D. Meters shall be suitable for measuring electrically conductive liquids, such as chilled and heating water, using a dual-electrode design with continuous auto-zero-function for improved accuracy and sensitivity. Provide basic loop power and integral temperature sensor suitable for mass flow measurement of chilled water. All wetted parts shall be Type 316 stainless steel and sensor head shall consist of polypropylene.

E. Provide options to include serial communications and multiple analog outputs for communication and monitoring by the energy management system.

F. All flow meters shall be calibrated in a flow laboratory against standards that are directly traceable to N.I.S.T. A certificate of calibration shall accompany each meter.

G. Temperature sensor shall be an integral 1000 ohm platinum RTD for precise temperature measurement.

H. Provide an empty pipe alarm accessory feature.

I. Flow meter design shall consist of all low maintenance, non-moving parts, which are all wear resistant.

J. Meters shall use advanced signal processing algorithms to ensure stable flow readings and reject noise. All meters shall be fully programmed at the factory and arrive on site ready to use once installed.

K. Each flow meter shall be the insertion type which shall be inserted through a one inch (1”) full ported ball valve using a one inch (1”) close nipple and branch outlet.

L. Accuracy shall be in the percent of reading as follows:

1. ± 1.0% of reading from 2 to 20 ft./sec.
2. ± 0.02 ft./sec. below 2 ft./sec.
3. Flow range: 0.25 to 20.0 ft./sec. (80: 1 turn down).

M. Sensing method shall be the electromagnetic sensing (no moving parts) type with integral piezoelectric sensors with integral temperature and/or pressure sensors as specified herein. Meters shall be suitable for measuring flows in pipe sizes 3” and larger.

N. Operating temperature ranges:

1. Ambient: -5°F to 150°F.
2. Process: 15°F to 250°F. (Conductivity range from 20 to 60,000 µ Siemens/CM).

O. Operating Pressure: Less than or equal to the rating of the flanges or 300 PSI.

P. Flow meters shall be the flanged style and be ANSI rated for Class 150 [150 or 300].

Q. Materials of Construction:

1. Sensor Body Type 316L stainless steel.
2. Wetted Parts: Type 316L stainless steel.
3. Electronics Enclosure: Epoxy painted aluminum; NEMA 4X rated enclosure.

R. Input Power:

1. 20-28 VDC; 250 mA at 24 VDC.
2. 20-28 VAC, 60 HZ, 6 VA.

S. On board meter display shall include 2-lines with 16 characters, alphanumeric LCD, with a backlighting feature. Standard display shall include a menu to display mass flow rate, temperature, pressure (where used; and calculated), mass flow rate totals over a specified time period) and associated alarms (if active). Provide an optional remote mount transmitter with a minimum cable length of 50 feet, with an option to extend up to 150 feet (maximum), as required.

T. Output (transmitter) Signals:

1. Analog Output (Isolated): 4-20 mA, 0-10V or 0-5V.
2. Frequency Output: 0-15 volt peak pulse, 0-500 Hz.
3. Scalable Pulse Output:
    a. Isolated Solid State Dry Contact.
    b. Contact Rating: 50 VDC, 100 mA maximum.
    c. Pulse Duration: 0.5, 1, 2 or 6 seconds.
4. Digital: BACnet MS/TP Serial Communications Protocol.

U. All flow meters shall be FM approved..

2.18 WATER USAGE METER

A. Furnish water meters where shown on the drawings, complete with totalizing electric contracting register, sized to meter twice the volume of the loop served by a common make-up water line supplied from a single location. Meters shall be installed by Plumbing Contractor. Where meters are used for a deduction program with the water utility, consult utility for specifications and requirements.

B. Provide 4-20mA signal from the controller to report to the BAS for trend logging the quantity of make-up water for each field and alarming the BAS upon excessive flow / leaking.

C. Provide 1 ½” flow meter with necessary accessories for integration with the BAS.

D. Acceptable Manufacturers:

1. Master Meter
2. Onicon
3. Others as specified by water utility

2.19 AIR FLOW MEASURING DEVICE

A. Where not provided with air conditioning equipment as integral to the unit, 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.
3. Sensor shall have a calibrated range of 0 to 5,000 FPM and have a minimum accuracy + 2% of reading over this range.
4. Probes shall be constructed of type 6063 gold anodized aluminum and have 10-foot plenum rated FEP cables.
5. Transmitter shall be constructed of industrial grade grade IC’s and have an aluminum chassis with a sliding cover.
6. Provide an RS-485 output to the Building Management System (BMS) 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. Ruskin
3. Others may be submitted for review and approval, but shall be equal.

2.20 AUTOMATIC VALVES

A. General

1. Automatic control valves shall be furnished by the control contractor and installed by the mechanical contractor.
2. Valves up to 2 inches shall be supplied with NPT threaded connections.
3. Valves 2 1/2 inch and larger shall be flanged with iron bodies. The body rating shall be 150 psig at 250°F.
4. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered.
5. Valves shall have hardened and polished stainless-steel stems and spring-loaded Teflon packaging with replaceable discs. Stems shall be polished stainless steel and packing shall be ethylene propylene suitable for both chilled water and heating water (250°F) systems.
6. All modulating straight through water valves shall be provided with equal-percentage contoured throttling plugs and tight closing seats.
7. All three-way valves shall have tight closing seats and be provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of the valve's position.
8. Valves shall be sized for a pressure drop equal to the coil they serve but not to exceed the pressure drops noted below.

    a. Heat Pumps: 4.0 psi

9. Two-position valves shall be the line size.
10. Unless noted elsewhere, valve pressure ratings shall be as required for the intended service.
11. Valves shall be as manufactured by

a. Belimo.
b. Siemens
c. Johnson Controls, Inc.
d. Bray: Flow-Tek

B. Modulating Control

1. Modulating control valves shown on plans and diagrams 1/2”-12” shall be electronically actuated characterized ball types with v-notch.
2. Characterized v-notch ball valves shall have a carbon steel valve body with raised face flanged connections, stainless steel stems, and PTFE seals.

C. Isolation Control

1. Ball Valves

a. Isolation control valves 1/2"-2 1/2" shall be ball valves with electronic actuation.
b. Valves shall have tight closing seats and be of the equal percentage type.

2. Butterfly Valves

a. Isolation control valves 2 1/2” and larger shall be butterfly type valves with electronic actuation.
b. Butterfly valves shall have tight sealing gaskets in contact with the wafer suitable for end of line pressure shut off, bubble tight.
c. Butterfly valves shall have single piece bodies.

1) Two (2) separate butterfly valves are not acceptable as a three-way valve.
2) Three-way butterfly valves shall consist of a single cast-iron flanged tee.

2.21 ELECTRONIC VALVE ACTUATORS

A. Electronic valve actuators shall be furnished under this section of specifications.

B. All control valves shall receive electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action and tight close-off.

1. Each control valve shall have a single actuator.
2. Stacked or multiple actuators on a single shaft are not permitted.

C. All modulating control valve actuators shall require position feedback to the BMS unless provided with flow feedback as specified elsewhere.

D. All isolation control valves shall have end position feedback to the BMS indicating open and close status. Such actuators shall have integral end switches.

E. Electronic direct-coupled actuation devices shall be provided.

F. 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.

G. 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. 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 or counterclockwise spring return operation by simply changing the mounting orientation.

H. 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 valve 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.

I. 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.

J. 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.

K. 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.

L. 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.

M. Actuators shall be Underwriters Laboratories Standard 873 listed.

N. Actuator enclosures shall be rated for their environments. Enclosures shall be NEMA 4X weatherproof for outdoor applications.

O. Size valve actuators for close off at 150% of total system (head) pressure for two-way valves. For three-way valves size for close off at 100% of differential pressure across the valve or 100% of total system (pump) head differential pressure.

P. 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.

Q. All actuators connected to all sequenced valves and dampers shall have independent control and adjustment from one another to emulate a pilot positioner.

R. Acceptable Manufacturer's:

1. Belimo
2. Siemens
3. Johnson Controls, Inc
4. Bray

2.22 AUTOMATIC DAMPERS

A. General

1. All automatic dampers will be provided by the Controls Contractor, but installed by the Mechanical Contractor.
2. 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.
3. Damper frames shall be not less than 16-gauge galvanized steel formed for extra strength with mounting holes for flange and enclosed duct mounting.
4. 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.

5. 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.
6. Blade bearings shall be nylon or oilite with 1/2" zinc plated steel shafts.
7. All blade linkage hardware shall be of corrosion-resistant finish and readily accessible for maintenance after installation.
8. 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.
9. Dampers and seals shall be suitable for temperature ranges of -20 degrees F to 200 degrees F at specified leakage ratings.
10. Dampers used for proportional control shall have opposed blades.
11. 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.
12. Acceptable manufacturers are as follows.

    a. Ruskin.
    b. Johnson Controls, Inc.
    c. Honeywell, Inc.
    d. American Warming and Ventilating, Inc.
    e. No other manufacturers will be allowed.

B. Uninsulated Electronically Actuated Dampers

    1. Provide uninsulated automatic dampers for distribution applications where air temperature on both sides of damper is essentially the same.
    2. Dampers shall be as equal to Ruskin CD-60.

C. Insulated Electronically Actuated Dampers

    1. Provide for intake and exhaust applications where damper separates interior air system with exterior outside air.
    2. Extruded aluminum 6063T6 frame (minimum 12 gage, 0.08” thickness).
    3. Frame shall be insulated on all four sides and thermally broken.
    4. Extruded aluminum 6063T5 blades (minimum 12 gage, 0.0808” thickness) shall be internally insulated with polyurethane foam, and thermally broken.
    5. Minimum R-value of insulated blade shall be 2.29°F•ft²/BTU/hr at 55°F.
    6. Blade seals shall be silicone.
7. Dampers shall be as equal to Ruskin TED50.

2.23 ELECTRIC DAMPER ACTUATORS

A. All control dampers shall receive electric actuators as furnished and installed under this section of Specifications.

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 or 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.

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.

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. Johnson Controls, Inc.
3. Siemens.

2.24 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, set point adjustable to +/-1% range from 0-95% non-condensing relative humidity

E. Sensors shall be as manufactured by one of the following.

1. Senva
2. Veris Industries, Inc.

2.25 OUTPUT DEVICES (RELAYS)

A. Interposing Relay

1. Interposing relays shall be used to provide remote circuit control of remote equipment, or to provide device status input for those devices which do not have an auxiliary relay contact output available.
2. Relay contacts shall be enclosed in a dust proof enclosure.
3. Relay shall be rated for a minimum of one million mechanical operations.
4. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less.
5. Interposing relay shall also meet the following requirements

    a. Rating: 150 Vac | 150 Vdc, 10 Amps
    b. Working Voltage: 120 Vac | 24 Vdc to 150 Vdc, nominal
    c. Contact Arrangement: DPDT (2 Form C)
    d. Base: Plug-in socket suitable for panel mounting

B. Control Relay

1. Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure.
2. Relay shall be rated for a minimum life of one million operations.
3. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less.

C. Time Delay Relay

1. Time delay relay contacts shall have utilization category and ratings selected for the application with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure.
2. Delayed contact opening or closing shall be adjustable from 1 to 60 seconds with a minimum accuracy of ± 2% of setting.

D. Latching Relay

1. Latching relay contacts shall have utilization category and ratings selected for the application with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure.
2. Relay shall be rated for a minimum life of one million operations.
3. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less.

4. Relay operation shall require separate control circuits for switchover from one position to another.

2.26 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 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.

1. Acceptable locations include mechanical equipment rooms, storage closets, electrical rooms, or other spaces as indicated on the Drawings.
2. Above ceiling locations are only acceptable for areas where HVAC equipment is also located above ceiling. Where located above ceiling, enclosures shall be installed at a height and location that can be accessed with a standard height ladder. Clearance shall be coordinated with other trades to permit access to the enclosure and its contents.

C. Thermometers, pilot light switches, and gauges shall be flush mounted on panel surface.

D. Cabinet frames shall be extruded aluminum sections with riveted corners supported by internal angle brackets. Door shall have continuous hinged door with latch. Where enclosures are not located in a space that is locked for maintenance staff, provide a key lock on the enclosure door. All keys on controls enclosures shall be keyed to a master key.

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 connection and 1-1/2" x 1-1/2" trough shall be provided at top and bottom of 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. Devices inside panels 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 LED 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.

2.27 ENERGY MANAGEMENT SYSTEM

A. 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 controller shall have an on-board 30-day battery backed 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.

B. 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.

C. Furnish and ship damper actuators and terminal unit controllers to the terminal unit manufacturer for factory installation. Refer to other specifications 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.

D. 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.
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 equipment over 2000 CFM in capacity, rooftop heat pumps, and controlled exhaust fans over 2000 CFM in capacity. Alternately, provide this capability integral with Direct Digital Controllers. Terminal units such as small exhaust fans, small A/C units, and smaller rooftop or heat pump 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 Management System. Verify dependable utilization of this system and transfer of local system data and functions to the existing control system CPU. General data reporting and alarms transmission shall be verified.
8. The existing central 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 remotely controlled. The existing central 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 at the existing computer 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.
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)

E. 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 aid 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.

F. 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:

1) Basic Arithmetic
2) Binary Logic
3) Relational Logic
4) Fixed Formulas for Psychometric Calculations

b. Utility Routines for:

1) Process entry and exit
2) Keyboard functions
3) Variable adjustments and output
4) Alarm Indication
5) Restart

c. Control Routines for:

1) Signal compensation
2) Loop control
3) Energy conservation
4) Timed programming

2. Final field programs shall be stored in battery backed up RAM or in permanent memory.

G. 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.

H. 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.

I. Battery Backup: 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. DDC modules shall have automatic restart capabilities with sequencing after a power failure without program interruption. This shall include the staggered re-start of all equipment over 1 HP in size in intervals of 15-30 seconds, adjustable. Provide for 20 equal size load groups.

J. 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.

K. 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.

L. 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.

M. 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.

N. U. L. Approval: The DDC system panels shall be an approved U.L. System, with U. L. listing as a Signaling System.

O. 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)
3. Time Programmed Commands
    a. Normal occupancy
    b. Holiday
    c. Occupancy overrides
    d. Schedules shall be programmable up to one year in advance with system wide or global scheduling and local, point by point scheduling.
4. Duty Cycle Control
5. Night Setback/Setup
6. Electric Demand Limiting
7. Override Feature
8. Run Time Totalization with data in non-volatile module memory.
9. Provisions shall be made for on-line programming and override.

P. On/Off Points of System Control shall be provided for the following:

1. Each domestic hot water recirculating pump control, refer to drawings for quantity. Coordinate with plumbing contractor for control requirements.
2. Each air compressor; coordinate with plumbing contractor.
3. Each electronic Damper actuators
4. Each electronic Valve actuators
5. Each EMS controlled pump, refer to drawings for quantity.
6. Each EMS controlled fan, refer to drawings for quantity.
7. Chiller Plant
8. Boiler Plant
9. Each EMS controlled AHU, refer to drawings for quantity.
10. Each Rooftop A/C Unit, refer to Drawings for quantity
11. Each Split DX A/C Unit: Refer to drawings for quantity
12. Lighting Controls:
    a. Soffit Lights, Wall Packs and Pedestrian (from building to parking lots)/Decorative Light Fixtures.
    b. Parking Lot Lights and Marquee Sign.

c. Courtyard Pedestrian Light Fixtures.

Q. Run Status (On/Off)

1. Run Status (On/Off) of all units indicated above shall also be provided and shall be capable of being accessed for on-line programming.
2. 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 single zone constant volume rooftop and horizontal suspended, and vertical, heat pump units and other constant speed fan motors for other air handling equipment.
3. For motors served by variable frequency drives utilize status from this equipment.
4. In addition to the above referenced equipment and systems, provide on/off run status for the following systems and/or equipment. Coordinate with the governing specification and supplying contractor for options provided for this monitoring. If no other provisions have been made, monitor status by means of a current sensing relay on the circuit providing power to the entity.

a. Coolers

1) Kitchen

b. Freezers

1) Kitchen

c. Fire Pump System
d. Domestic Water Booster Pump System
e. Kilns
f. Electric Unit Heaters (refer to drawings for quantity)

R. Failure Alarm Status

1. For the following EMS controlled items, provide failure alarm status through the EMS.

a. Combined Safety Alarm, one (1) for each of the following. This shall include loss of condenser water flow for heat pumps.

1) Roof top air conditioning units
2) Suspended horizontal and vertical heat pumps
3) A/C units
4) Energy Recovery Ventilation Units (ERV)
5) Geothermal well field pumps
6) EMS controlled exhaust fans

b. Low/High Temperature Alarms for each temperature sensor installed, four (4) Deg.F. above or below set point, adjustable.
c. High Relative Humidity Alarm for each space relative humidity sensor installed; on a rise above 65% R.H., adjustable.
d. High Carbon Dioxide Level Alarm for each carbon dioxide sensor installed, on a rise above 1100 Parts Per Million, PPM, adjustable.
e. Kitchen Walk-in Cooler/Freezer High Temperature alarm
f. Emergency condensate overflow (high water) pan water detection for all suspended Heat Pump and D/X A/C units.
g. Dirty Filter Status for each ERV (2 filter banks per unit).
h. Each variable frequency drive fault condition: Refer to plans for quantity (pumps and ERV's).
i. Power leg failure for 3 phase power circuits.

2. Also provide failure alarm status for the following items and systems.

a. Coolers

1) Kitchen

b. Freezers

1) Kitchen

c. Fire Alarm System
d. Domestic Water Booster Pump System
e. CO Sensors
f. Utility power, each phase (Coordinate with Division 26 specifications)
g. Building power, each phase (Coordinate with Division 26 specifications)

S. Provide for two annunciation signals for each controlled system, one to indicate that the heating system is operational and one to do the same for the cooling system.

T. Provide cumulative run time logging and indication for equipment noted in Paragraph "Q", above.

U. Provide analog indication for the following:

1. For each Water-to-Air Unitary Heat Pump Unit or A/C Unit, provide analog indication of the following:
   a. Supply air discharge temperature, Deg.F.
   b. Zone/space temperature, Deg.F.
   c. Space relative humidity % R.H.; Refer to floor plans. All heat pumps shown to be connected to a space relative humidity sensor shall include hot gas reheat for humidity control.
   d. Space carbon dioxide, PPM: Refer to floor plans for locations.
   e. Provide for remote reset for each heat pump.
2. Provide indication of outside air temperature in Deg.F for this building.
3. Provide indication of outside are relative humidity in % R.H. for this building.
4. Space Temperature, Degrees F:
   a. Electrical Rooms, refer to plans for quantity
   b. Kitchen Dry Storage Room
   c. MDF (Communications) Rooms
   d. All IDF Rooms, refer to plans for quantity
5. Provide pressure indication for each Geothermal Well Loop (Condenser), PSI, one (1) per well field for a total of seven (7).
6. Provide water temperature indication for the following:
   a. Geothermal well loop (condenser) water supply temperature, Deg.F., one (1) per well field for a total of seven (7).
   b. Geothermal well loop (condenser) water return temperature, Deg.F., one (1) per well field for a total of seven (7).
7. Provide feedback of variable frequency drive operating frequency, or speed, for drives serving the following equipment:
   a. All ERV's; for both supply and exhaust fans. Refer to plans for quantities.
   b. Geothermal Well Field Loop Pumps (Total of 14, 7 primary and 7 redundant pumps).
8. For each unit designed to have a VFD as shown in the Paragraph above. Refer to sequences of operation for how each VFD is to be controlled.
9. Energy Recovery Units:
   a. Unit Discharge (into building) Air Temperature, Deg.F.
   b. Exhaust air temperature entering unit, Deg.F.
   c. Exhaust air temperature leaving unit, Deg.F. (Discharge to outdoors).
   d. Supply (to building) air duct static pressure, inches W.G. (for supply fan control).
10. Relative Humidity, Percent R.H.:
    a. Crawlspace, refer to drawings for quantity and location
    b. Elsewhere as shown on the drawings.
11. Electrical Switchgear Power Monitoring System

a. Electrical power monitoring system to be provided by Division 26. Refer to Division 26 specification for points to be provided by the power monitoring system.
b. Map out available data to include volts and amps per phase, KWh and KW demand as a minimum.
c. Refer to Electrical Plans for quantity and locations.
d. Coordinate with Electrical Contractor for actual devices to be installed and integration with the BAS.
e. Under this section of specifications furnish necessary components to provide a successful integration these systems.

12. For each new single zone rooftop A/C unit, provide indication for each of the following:

a. Supply air discharge temperature, Deg.F.
b. Zone space temperature, Deg.F.
c. Space carbon dioxide level, parts per million (PPM), shall consist of an analog input signal to provide modulating control of the outside air intake, return and relief air dampers. Refer to floor plans for location. This is not required for all RTUs.
d. Space relative humidity, % R.H.
e. Space carbon dioxide, PPM: Refer to floor plans and schedules for locations.

13. Make-up Water to Geothermal Systems in Gallons, 7 total meters to be furnished under this Specification Section.

V. 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

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 9600 Baud Rate.
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.

2.28 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. The Controls Contractor shall provide / install wiring and sensors / instrumentations, but the Electrical Contractor shall provide the conduit and back boxes unless noted otherwise. The Controls Contractor shall coordinate with the Electrical Contractor to ensure the installation is successful.

D. 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.

E. All wiring, including Class 2 signal wiring, shall be installed as a Class 1 electrical system as defined by the National Electrical Code (NEC).

F. All control conduits with #8 conductor or smaller (cross-sectional area) shall have one (1) spare conductor each run in conduits carrying 5 or more conductors. Spare conductor shall be same size as the majority of conductors sized in the conduit. Conduits with 9 or more conductors shall have two spare conductors. Terminate spare conductors at control panels in an acceptable manner and tag wires as “spare”.

G. The electrician shall be licensed by the City and local authorities having jurisdiction over the area in which the work is to be performed.

H. 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.

I. 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.

J. All wiring shall be run in conduit. 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. Class 2 signal wiring may be installed above accessible lay-in ceilings only if run-in plenum rated cable supported independently from structure and run parallel and perpendicular to the structure.

K. 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).

L. The Controls Contractor shall coordinate with the Electrical Systems Installer on project regarding scope of work. The Electrical Contractor shall install control and back boxes (unless noted otherwise). This portion of work performed by the Electrical Contractor shall be bid directly to the Temperature Control Systems Installer, and all work in relation to control wiring shall be done subordinate to this Section of the Specifications. Wiring terminations shall be under this Section of the specifications.

M. Under this Section of Specifications, coordinate the furnishing and installation (by the job site electrician), at an early stage of construction (when walls are being constructed), of 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. This will also require the installation of pull wire for the installation of sensors and related wiring at a later stage of construction under this Section of Specifications.

N. 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, and HVAC Energy Management Systems in accordance with approved rough-in and connection diagrams furnished by the system suppliers. Refer to Division 26 Drawings.
5. All new branch circuit wiring, conduits, protective devices and accessories for power wiring to serve new control panels, control transformers, electric control dampers and valve actuators, combination fire-smoke dampers and any other control system power requirements. Coordinate all work with other trades. Field verify spare electrical circuits are 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.
6. The above represents an outline of the work for the purpose of describing one division of the work which is acceptable to ensure 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.
7. 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.

O. Work Included Under this Section 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 ensure 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.

P. Contractor, under this Section of the Specifications, shall ensure the furnishing and installation of:

1. 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.
2. 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.

Q. Wire all safety devices in series to include freezestats, firestats, smoke detectors, and static pressure high limit controls; any single device when tripped, shall de-energize air handling equipment.

R. Wiring Requirements shall also include the following:

1. The conduit/wiring system required for the ATS/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 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.
3. 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.
4. 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.
5. 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.
6. AC line power to DDC panel shall be #12 THHN.
7. Digital Output (D.O.) wiring shall be #14 THHN.
8. 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).
9. Analog Input or voltage types (A.I.) wiring shall be #18 TSP (twisted shielded stranded pair with drain wire).
10. An additional 15-20’ service length of cable shall be provided for sensors installed in the Main Building Administration areas.

2.29 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 piping 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 Section 23 0500 and 23 3000.

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 Controls Contractor. They shall be installed by the Mechanical Contractor. They shall be adjusted for proper operation, including the installation of necessary linkages with actuators under this section of specifications in concert with the Test and Balance Contractor. The Mechanical Contractor shall furnish and install any necessary blank-off plates required 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.

2.30 BUILDING AUTOMATION

A. Description - Provide a Building Automation System (BAS) incorporating BACnet MS/TP technology at the controller level, network device level, and the network management tool. The BAS shall consist of Direct Digital Control (DDC) controllers, Building Controllers (BC), Graphical user Interface through standard Web browsers, sensors, relays, valves, actuators, and other equipment as may be necessary to provide for a complete and operational control system for the HVAC and other building related systems as described and listed within these specifications.

1. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e. HVAC, lighting, and security devices should easily coexist on the same network channel without the need for gateways, BACnet MS/TP components not supplied by the primary manufacturer shall be integrated to share common software for network communications, time scheduling, alarm handling, and history logging.
2. The documentation contained in this section and other contract documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions shown or an implied in the contract documents.
3. System configuration and monitoring shall be performed via a PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data.
4. All unitary controllers and all other field controllers for the HVAC system shall be provided by one manufacturer. BACnet MS/TP components not supplied by the primary manufacturer shall be integrated to share common software for network communication, time scheduling, alarm handling, and history logging.
5. All system controllers shall utilize a peer-to-peer communications scheme to communicate with each other.

B. Open Systems Design - It is the owners express goal to implement an open Building Automation System that will allow products from various suppliers to be integrated into a unified system in order to provide

flexibility for expansion, maintenance, and service of the system. The BAS provided shall maintain open interoperability in the following areas.

1. Communications - The intent of this specification it to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135 BACnet MS/TP communication protocols in one open interoperable system.
2. Network Management - Network management tools shall be based upon BACnet MS/TP. All tools and hardware provided shall comply with industry standards including ANSI/ASHRAE™ Standard 135, BACnet to assure interoperability between all system components is required.
3. User Access: The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
4. Databases - All controller program graphics and network databases shall be provided in a format useable for the Owner. The database shall be stored on the owner PC and provided on a separate CD upon final acceptance of the project. An updated database shall be provided on a CD at the end of the warranty period.
5. Network level Devices - All network level devices shall have communication interface between the BACnet and the Ethernet.
6. Field Level Controls - All field level controls shall be certified to the current BTL standards appropriate to their application so long s an appropriate BTL Certification standard exists. All points withing a controller including hard I/O and software-based points such as (constants, variables, NVI, NVO, SCPT, UCPT, SNVT, UNVT) shall be available for viewing and manipulation through any BACnet MS/TP based network device management or Graphical user Interface (PC based or Browser) tool. Any products that use explicit messaging shall not be acceptable.
7. Software Tools - All software tools needed for full functional use, including programming of controllers, network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the owner of his designated agent. Any licensing required by the manufacturer now and into the future, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and serving shall be provided. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.
8. SOFTWARE LICENSE AGREEMENT - The Owner shall sign a copy of the manufacturer's standard software and firmware agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's rights to disclosure of trade secrets contained within such software. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code, databases and documentation for al configuration and programming that is generated for a given project and/or configured for use with the BC, BAS Server(s), and any related LAN/WAN/Intranet connected routers and devices. Any and all required IDS and passwords for access to any component or software program shall be provided to the owner. The System Integrator shall provide as part of the submittals a copy of Niagara Compatibility Statement (NICS) verifying that all aspect of the Niagara Framework maintain an Open System Design. The System as provided shall confirm with the following NICS."

C. Other Systems to Integrate through BACnet

The following equipment and systems have been designated for BACnet MS/TP integration and shall be integrated to the building automation system / energy management system. Refer to other specification divisions for requirements and provided points. The Controls Contractor shall coordinate with other contractors for specific products selected and approved for installation as well as oversee that the systems are integrated into a functional BAS. The Owner's preference is to control these systems through the BAS user interface.

1. Central Battery Systems
2. Electrical Lighting Controls System

PART 3 - SEQUENCES OF OPERATION

3.1 DOMESTIC HOT WATER RECIRCULATING PUMPS; REFER TO PLANS FOR QUANTITIES

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 aqua-stat, 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°F below set point, the respective pump shall be energized.

3.2 SEQUENCE OF OPERATION - HVAC FANS

A. Where fans are to be controlled with light switches, provide interlock wiring as required to accomplish this requirement under Division 26.

B. Purge exhaust fans (refer to plans, such as in the science classroom) shall be provided with locally manually controlled motor starters (provided under Section 23 05 14 and installed under Division 26). Purge exhaust fans shall be interlocked with wall mounted red mushroom style pushbutton located as shown on the drawings (see the drawings and coordinate with Architecture). When the purge exhaust fan control button is pushed, the purge fan shall be energized for 30 minutes, adjustable.

C. Central Dust Collector

1. Dust collector shall be energized and de-energized by means of a push-button starter with a timer, adjustable, that de-energizes it after 60 minutes if not manually stopped sooner.
2. Coordinate with dust collection equipment vendor.

D. Storm Shelter Ventilation Fans

1. For sequence of operation for storm shelter fans, please refer to drawings.
2. These fans shall be shall be activated by a push button wall switch located in the shelter (see the drawings).
3. The fans shall be powered by the storm shelter inverter.
4. The fan’s speed controller shall allow for a soft start. The fan shall slowly ramp up to full speed and operate for the duration of the storm event which end shall be indicated by toggling the push button wall switch.
5. See the storm shelter drawing for additional sequences of operation required for operation of the shelter and controlled dampers associated with the operation of the shelter ventilation exhaust fans.

E. Exhaust fans designated to be interlocked shall be interlocked with the item noted on the schedule, be provided with local, manually controlled motor starters (provided under Section 23 05 14 and installed under Division 26) where manual switches are scheduled and where specified in other sections of these specifications.

1. Kitchen Hood Exhaust Fans

a. Integrate kitchen grease hood exhaust air fans with demand control kitchen ventilation (DCKV) system controller provided by Division 11.
b. Provide local manually controlled motor starters (provided under section in 23 0514 and installed under Division 26) where manual switches are scheduled and where specified in other sections of these specifications. Remote “on” signal from BMS may be sent to the DCKV system controller to start the fan and increase speed from 0-10 Vdc or to decrease speed and de-energize when an “off” signal is sent.

c. Manual activation of the fan switch on the DCKV touchpad or activation from the DCKV system controller may start the fan at minimum speed and automatically adjust exhaust air flow rate based on actual cooking loads as sensed by the temperature and optic sensors mounted in the hood. DCKV system controller to send start/stop and 0-10 Vdc or 4-20 mA signal to BAS.
d. In auto mode the temperature sensor detects heat levels and upon a rise above 90°F the fans shall turn on automatically by means of a signal from the DCKV system controller.
e. Manual deactivation of the fan switch on the DCKV touchpad or deactivation from the DCKV system controller shall stop the fan.
f. Coordinate with DCKV controls installer to integrate kitchen grease hood exhaust air fans with respective fire suppression system of hood served regarding fan operation during discharge of suppression agent as required by local Code. In the event of a fire the DCKV system controller turns off, the exhaust fan shall run at full speed.
g. Make-up air control is included under control sequences for the units providing make-up air.

2. Range Hood Exhaust Fans

a. Coordinate with hood installer for integrating fan operation with hood operation by hood controller.

1) Fan shall energize when exhaust hood is "on".
2) Fan shall adjust speed upon signal from hood controller.
3) Fan shall de-energize after 5 minutes (adjustable) of hood turning "off" at the hood controls interface.

b. Control hood exhaust air fan with respective fire suppression system of hood served to operate exhaust air fan properly during discharge of suppression agent as required by local Code.
c. Provide for the interlock with the hood manufacturer-furnished exhaust air thermostat which shall energize the hood exhaust air system upon a rise in temperature above its set point.
d. Provide local manually controlled motor starters (provided under section in 23 0514 and installed under Division 26) where manual switches are scheduled and where specified in other sections of these specifications.
e. Make-up air control is included under control sequences for the units providing make-up air.

3. Kitchen Dishwasher Exhaust Fan

a. Kitchen dishwasher machine exhaust fan shall be integrated with dishwasher machine to immediately be energized when the dishwasher is started or the booster heater is started.
b. 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 and booster heater are both de-energized.

4. Kiln Hood Exhaust Fan

a. Kiln hood exhaust fan shall energize when the kiln served by the hood is energized.
b. Kiln hood exhaust fan shall de-energize 30 minutes (adjustable) after the kiln served by the hood is de-energized.
c. Kiln hood exhaust fan shall energize when the kiln hood exhaust fan switch is toggled to the on position. If the switch is in the off position and the kiln is not on, then the kiln hood exhaust fan shall de-energize.

F. Dryer Exhaust Duct Power Ventilator

1. Dryer exhaust duct power ventilators (DEDPV) shall operate by means of a manufacturer furnished, Mechanical Contractor installed pressure sensor in the dryer exhaust ductwork.
2. When positive pressure is sensed for more than 10 seconds, the DEDPV energizes.
3. The DEDPV operates until the sensor no longer senses positive pressure.
4. Once positive pressure is no longer detected, the DEDPV operates for an additional 5 minutes before de-energizing.

G. Where fans are designated to be thermostatically controlled (EMS: TEMPERATURE), 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 integrated dampers, as applicable, shall be closed. Where fans serve the same space as unit heaters, furnish an EMS temperature sensor and controller to control and monitor the room (individual thermostats for the fan and heater not allowed) such that heating and cooling cannot occur simultaneously.

1. Ventilation Fans for space above coolers/freezers

    a. Ventilation fans used for moving air above coolers or freezers shall mechanically ventilate the space above the walk-in cooler/freezer as described herein.
    b. The fan shall be energized as required to control the temperature within the plenum, no higher than 80°F, adjustable.
    c. The fan shall de-energize when the temperature in the plenum drops 4°F (adjustable) below the set point for five (5) minutes (adjustable).
    d. The fan shall be energized, as required, to control the humidity within the plenum, no higher than 65% RH.

2. Where a fan may also be controlled manually by a wall switch (with a time delay) such as in the dry storage of the kitchen, the fan shall energize on a rise in space temperature if not already energized and shall remain energized even if the switch is off until the temperature falls below the set point noted above at which time it shall de-energize. If the temperature does not call for the fan to be energized, but the switch activates the fan, then the fan shall be energized and shall run for 30 minutes (adjustable) after which time the fan shall de-energize.

H. Fans so designated on the fan schedules to be controlled by EMS: SCHEDULE (see fan schedules), shall run continuously during normal occupied mode for the building and de-energized during other modes of operation.

I. The underfloor (crawl space) area that shall be mechanically ventilated by a roof mounted exhaust fan, as shown on the drawings (Refer to Mechanical Drawings and Schedules), shall operate as described herein. The intake air shall be introduced through air intake openings.

1. Anytime the outside air temperature is above 45°F, adjustable, the dampers in the ductwork connected to the areaways and exhaust air fan shall open. Then upon proof of the dampers in the open position, the crawlspace exhaust fan shall be energized for timed intervals, every 24 hours. The fan 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. The dampers shall remain open.
2. Additionally, provide crawl space relative humidity sensors as shown on the drawings. Whenever the relative humidity in the crawl space rises above 60% R.H., adjustable, at any sensor, then override the time schedule and operate the exhaust fan until the relative humidity drops below 55% R.H., adjustable, at all humidity sensor locations in the crawl space.
3. Anytime the outside air temperature is below 45°F, adjustable, the fan shall de-energize. With proof of fan run status as “OFF” the motorized electrically actuated dampers in the ductwork connected to the areaways and exhaust air fan shall close to prevent air from entering through the areaways into the crawlspace and leaving the crawlspace through the exhaust air duct.
4. Lock-out the time schedule operation when the outside air temperature is below 45°F, adjustable.

J. Relief Fans

1. Relief Air Fans shall operate in coordination with the operation of the variable air volume air handling units that serve the same area of the building as the relief air fan. See sequences of operation for the variable air volume air handling units.
2. When the space pressure rises above a set point of 0.03 in w.g. (adjustable) or when the maximum outside air dampers are modulated open, the relief air system shall be energized.
3. When the relief air system is energized, automatic control dampers in relief air ducts shall open. Once the relief air dampers are opened, then the relief air fan shall be energized.
4. The relief air fan shall modulate to maintain space pressure or proportionately to the position of the outside air damper.

5. As the space pressure drops to below set point for 5 minutes (adjustable) or if the outside air damper modulates from its maximum position, then the reverse sequence shall occur.

K. Chiller Room Exhaust Fan

1. The fan serving the chiller room shall have a normal mode of operation and an emergency mode of operation.
2. Normal Mode
    a. During normal mode, the fan shall operate based on a programmed schedule to initially match the occupied schedule of the building and shall be adjustable.
        1) When initiated to energize, the fan shall energize and increase in speed to the normal operating volumetric air flow rate scheduled.
        2) When initiated to de-energize, the fan shall de-energize.
    b. During normal mode, if the temperature sensor in the space exceeds 80°F the schedule shall be overridden and the fan shall energize and increase speed as needed to maintain an 80°F (adjustable) set point. Upon a decrease to 78°F (adjustable) for 15 minutes (adjustable) the fan shall de-energize.
3. Emergency Mode
    a. The BAS shall receive an input signal from the refrigerant monitoring system to activate the emergency mode of operation.
    b. The BAS shall receive an input signal from the emergency push-button wall switch to activate the emergency mode of operation.
    c. During emergency mode, the fan shall energize and increase to full speed as noted on the fan schedule for emergency operation.
    d. The fan shall exit emergency mode and return to normal operational mode upon reset from the refrigerant monitoring system.
4. Outside Air Damper Control
    a. An associated motorized control damper shall open, modulate, and close in coordination with the exhaust fan.
    b. The damper shall open when the fan is energized.
    c. The damper shall modulate when the fan increases and decreases speed.
    d. The damper shall close when the fan is de-energized.

3.3 SEQUENCE OF OPERATION - NIGHT SET-BACK AND SET-UP MODES

A. Night Set-Back

1. A night set-back mode shall be provided to keep equipment from operating except as needed to heat the space to protect the building systems from freezing and potential water damage.
2. A space temperature sensor shall be used for night set-back control and shall be set for 55°F. Respective units shall be energized and operate to satisfy the heating set point. On a rise in space temperature to 60°F, adjustable, de-energize the unit.
3. For night set-back mode, lockout cooling system, ventilation cycles, morning warm-up mode, morning cool-down mode, and night set-up mode. Close all outside and relief air dampers and de-energize all EMS controlled toilet exhaust fans located in the spaces served.

B. Night Set-Up

1. A night set-up mode shall be provided to prevent excessive heat and humidity build-up in the building.
2. For the night set-up mode, the set point shall be 85°F and the cooling system shall cycle off when the space temperature drops to below 80°F, adjustable.
3. For night set-up mode, lockout heating system, ventilation cycles, morning warm-up mode, morning cool-down mode, and night set-back mode. Close all outside and relief air dampers and de-energize all EMS controlled toilet exhaust fans located in the spaces served.

3.4 SEQUENCE OF OPERATION - MORNING WARM-UP MODE AND COOL-DOWN MODES

A. Morning Warm-Up

1. A morning warm-up mode shall be provided to warm the building, or area served by a system, to within 1°F of the normal occupied heating set point, adjustable, through the building Energy Management System optimized start feature.
2. Warm-up shall function the same as night set-back, except the set point shall be as noted above (within 1°F of the normal occupied heating set point, adjustable).
3. Lockout the warm-up mode after the cycle is completed until the following scheduled cycle, generally not to occur more than once per day.
4. Lockout cooling system, ventilation cycles, night set-back mode, morning cool-down mode, and night set-up mode. Close all outside and relief air dampers and de-energize all EMS controlled toilet exhaust fans.

B. Morning Cool-Down

1. A morning cool-down mode shall be provided to cool the building or area served by a system to within 1°F of the cooling set point, adjustable, through the building energy management system optimization start feature.
2. Morning cool-down will be similar to night set-up except the set point shall be to within 1°F of the normal cooling set point.
3. Lockout the cool-down mode after the cycle is completed until the following scheduled cycle, generally not to occur more than once per day.
4. Lockout heating system, ventilation cycles, morning warm-up mode, night set-up mode, and night set-back mode. Close all outside and relief air dampers and de-energize all EMS controlled toilet exhaust fans located in the spaces served.

3.5 SEQUENCE OF OPERATION – CHILLED WATER PLANT

A. System Overview

1. The majority of spaces in the main building are cooled by a centralized chilled water plant consisting of the chillers shown on the plans and cooling towers with associated pumps. See the drawings. The chillers shall be equipped with water-side economizers.
2. Equipment and devices in the system
    a. Cooling Towers
        1) CT-1
        2) CT-2
        3) VFDs for each tower’s fan
        4) Control Valves on CWR line at each tower
        5) Control Valve in condenser water bypass line
        6) Basin Filtration System, BFS-1
        7) Basin heaters
        8) Vibration cut off switch in each tower
        9) Make-up water meter
    b. Condenser Water Pumps
        1) CWP-1
        2) CWP-2
    c. Water Cooled Chillers
        1) WCCH-1
        2) WCCH-2
        3) WCCH-3
        4) Control Valves
        5) Flow Meter

d. Chilled Water Pumps

1) PCHP-1
2) PCHP-2
3) PCHP-3
4) CHP-1 with VFD
5) CHP-2 with VFD
6) CHP-3 with VFD

e. Refrigerant Gas Detection System

B. Cooling Towers

1. The cooling tower fans shall be staged on and start any time condenser water pumps are operating. The cooling tower fans shall be controlled by variable frequency drives to maintain the maximum condenser water supply temperature set point of 85°F (adjustable). Start all cell fans at minimum speed at the same time as the condenser water supply temperature rises above 75°F (adjustable). With all fans at a minimum speed and on a further rise in condenser water temperature, all fans shall uniformly increase in fan speed as required to prevent the condenser water supply temperature from exceeding 85°F (adjustable).
2. On a drop in water temperature below 85°F (adjustable), the fans shall be decreased in speed in the reverse sequence of that specified above. On a drop in water temperature to 75°F (adjustable), all fans shall be de-energized. On a further drop in water temperature, the bypass valve shall modulate open to divert flow from the cooling towers to the cold-water basin to maintain a minimum 70°F condenser water supply temperature, adjustable.
3. Provide for condenser water relief by resetting the condenser water supply temperature downward from 85°F to 75°F based on a reduction in the outdoor air temperature from 100°F down to 70°F, adjustable. In no case shall the condenser water supply temperature drop to below 65°F, unless otherwise allowed by the chiller manufacturer.
4. The tower fans shall be locked out when the outside air temperature is below 40°F, adjustable.
5. The tower basin heaters and controls shall be furnished by the tower manufacturer and shall be independently hardwired and controlled, per basin, under this Section of Specifications. With the tower fans off, on a drop in basin water temperature below 35°F, the heaters shall be energized; and, on a rise above this temperature, (2°F differential, adjustable), the heaters shall be de-energized. Individual low water cut-out switches shall prevent heaters from operating when elements are not completely submersed. Low water cutout switches and thermostats are furnished by the tower manufacturer. Install and wire under this Section of Specifications.
6. Monitor the cold-water make-up quantity through the make-up water meter. Report an alarm to the building automation system when make-up water quantity exceeds the cooling tower manufacturer's recommendations by 10%, adjustable. Coordinate compatibility of meter and pulse signal. Dual meters are not acceptable.
7. Each tower fan motor shall be furnished with a vibration cut-out switch by the tower manufacturer, which shall be wired under this Section of the Specifications to de-energize the respective fan when vibration becomes excessive. This shall be manually reset.
8. When the smaller, pony chiller is operated as the only energized chiller, only one tower shall be operated. The respective tower’s valve shall modulate to the open position, then the tower shall be energized and the fan shall modulate and be re-set as noted above, but with only one tower. When the smaller, pony chiller is de-energized and one of the other, larger chillers is energized, then the valve on the second tower shall open and that tower shall be energized and both tower fans shall modulate to the minimum fan speed and the sequence previously stated shall be followed without de-energizing the lead tower.
9. When the smaller, pony chiller is operated as the second chiller due to a failure of one of the other larger chillers to start, then the towers shall be operated as noted previously for two chillers.

C. Chillers and Pumps

1. The liquid chiller system shall be energized by the energy management system and software integrated to run when any air handling unit or group, as designated by the Engineer, of fan coil units served with chilled water is energized, requires cooling and the economizer cycle cannot meet load demand. Provide manual disconnect for each control circuit.
2. Primary chilled water pumps shall be started and de-energized by a hard-wire interlock with their chiller’s associated condenser water pump under this Section of the Specifications. Chillers shall be

started after a one-minute time delay (adjustable) after the primary chilled water pump and associated condenser water pump are started and proof of flow is verified. Lock out the chillers, primary chilled water pumps, condenser water pumps, and cooling tower below 38°F outside air temperature, adjustable.

3. Provide a primary chilled water return temperature sensor set at 54°F, adjustable, to energize the lead primary chilled water pump, its associated condenser water pump, and the respective chiller served after proof of flow is verified. Start the second (lag) primary chilled water pump, its associated condenser water pump, and chiller in the same manner after a rise of common secondary pump discharge temperature of 2°F, or more, adjustable, above chiller setpoint, initially set at 42°F, for 30 minutes or longer, adjustable. Turn on the third primary chilled water pump, its associated condenser water pump, and chiller in a similar manner.
4. Turn off second, lag chiller and respective primary pumps, with auxiliaries, one at a time, 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°F above chiller setpoint, i.e., less than 44°F, adjustable, and the temperature difference of the secondary supply and primary return is less than 5°F, adjustable.
5. Alternate starting of chillers, respective primary pumps, and auxiliaries to provide even distribution of operating hours for the three chiller systems through software. The larger, equally sized chillers shall generally be the primary operating chillers and shall alternate lead roles after each start. The smaller, pony chiller and respective primary pumps shall be utilized only when needed to supplement the primary chillers or for after-hours or summer school or in fall or spring when the outside air temperature is below 60°F, adjustable, in which case, it shall become the primary lead chiller. The larger, equally sized chillers, with respective primary pumps, would then become lag chillers and be energized when load necessitates it. When the smaller, pony chiller is operated as the lead chiller and there is a need for a second chiller, the second chiller (either one of the larger, equally sized chillers which was previously the lead chiller) shall be energized and after proof of flow, the smaller, pony chiller shall be de-energized and larger chiller shall operate as lead chiller. If load falls below minimum capacity of the larger chiller, then the smaller, pony chiller shall be energized and the operating chiller de-energized. Provide a BacNET interface to each chiller and monitor the load on each chiller. Typically, when the chiller load drops below 10-15% on Chiller No. 1 or 2, and only one chiller is energized, the lead chiller will be de-energized and the smaller, pony chiller will be energized. Chiller manufacturer and TAB firm to confirm exact load percentage setpoints.
6. Initially, one primary chilled water pump, its associated condenser water pump, and chiller with auxiliaries will start and as load increases beyond the capacity of that chiller then the second and then the third chiller system will be energized. As load decreases, the reverse shall occur.
7. Chiller capacity shall be controlled by individual chilled water discharge thermostats for each chiller, set at 42°F (adjustable).
8. Chiller safety and operating controls shall be master over auxiliary controls.
9. Chillers shall be turned on only after respective primary chilled water pump and the associated condenser water pump have started and proof of flow is made in both the evaporator and condenser. 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.
10. Provide differential pressure flow switches, under this Section of the Specifications, if not specified to be furnished with the chillers, in the chilled water and condenser 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.
11. Provide other interlocking relays to de-energize pumps as required by safety controls of chiller manufacturer, under this section of the specifications.
12. 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.
13. Any time a primary pump is energized the designated chilled water distribution pump shall be started and be controlled as indicated elsewhere herein.

D. Chilled Water Distribution System

1. Chilled water distribution pumps CHP-1, CHP-2, or CHP-3 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.
2. 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.
3. Chilled water distribution pumps CHP-1, CHP-2, and CHP-3 shall be connected to separate variable frequency drives such that one pump is operated from its respective variable frequency drive, or manual bypass starter, but no two pumps 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.
4. Chilled water distribution pumps CHP-1, CHP-2, and CHP-3, 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. The lead pump shall be started at minimum pump manufacturer’s recommended speed and ramp up to 90% speed to maintain the system design differential pressure set point. If the pump is unable to maintain the design differential pressure set point, the lag pump shall be started and the lead pump shall reduce in speed to 40% speed. The pumps shall then modulate together to maintain pressure in the system. When the pump speed for both pumps drops below 25%, the lag pump shall be de-energized and lead pump shall be modulated to control system pressure. Only two (2) pumps shall operate at any given time. The third pump is a redundant pump.
5. Provide five (5) differential pressure sensors with transmitters near the extreme ends of the chilled water piping, at the chilled water coil of AHU-A03, AHU-D02, AHU-N03, AHU-Q03, and AHU-K01. The design differential of greatest demand shall be maintained through the variable frequency drive modulating the speed of the active distribution pump(s). 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.
6. During chilled water distribution system freeze protection, all inactive air handling 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°F, the building is secured (generally unoccupied); air handling units are generally all off, and not operating in a night set-back or morning warm-up mode.

E. Refrigerant Gas Detection System (RGDS)

1. Immediately upon pre-alarm level detection

   a. BMS system shall be alerted of pre-alarm condition by RGDS.
   b. Outside air damper on louver opens and emergency exhaust ventilation fan is energized, activated, and increased to full speed air flow where VFD is used.
   c. The control panel displays detector gas levels and indicates “pre-alarm” status for the detector in alarm.
   d. The detector displays levels in yellow.

2. Immediately upon high alarm level detection:

   a. BMS system will be notified of high alarm condition.
   b. Remote audible and visual alarms outside of the exits will activate.
   c. Purge fans connected to the RGDS control panel will remain energized.
   d. All refrigerant compressors, refrigerant pumps, and any other specified potential ignition sources must be shut down.
   e. All specified normally closed refrigerant solenoids must be de-energized and closed.
   f. Internal control panel buzzer will sound.
   g. The control panel will display the zone location of the detector in alarm and its corresponding PPM level.

h. The detectors will display the alarm level in red.
i. Internal detector buzzer will sound.
j. The system will remain in alarm until reset manually at the control panel.

3. Upon activation of the emergency shutdown switch:

a. Emergency shutdown switch shall be interlocked with the control circuit that shuts down refrigerant compressors, refrigerant pumps, solenoid valves, and potential ignition sources.
b. All pieces of equipment specified above, will de-energize and shutdown.

3.6 SEQUENCE OF OPERATION – HEATING WATER PLANT

A. System Overview

1. The majority of spaces in the main building are cooled by a centralized heating water plant consisting of the boilers shown on the plans with associated pumps. See the drawings.
2. Equipment and devices in the system

a. Boilers

1) B-1
2) B-2
3) B-3
4) Control Valves

b. Pumps

1) HWP-1 with VFD
2) HWP-2 with VFD
3) HWP-3 with VFD

B. Boilers

1. The heating water system shall be energized whenever the building is in “winter” or “heating” mode and outside air temperature drops below 68°F (adjustable), or 20% (adjustable) or more of the VAV terminals, or three (3, adjustable) or more of the air handling units have a demand for heat (heating set points are not satisfied). When the system is called to be energized the lead heating water pump will be first started and the associated isolation valve for the lead heating water boiler opened. Upon proof of water flow through the lead boiler it shall be energized.
2. Start the lag boiler after the minimum design flow for two (2) boilers is maintained for 15 minutes (adjustable) or longer, a drop of common pump discharge temperature of 2°F, or more, adjustable, below the heating water reset temperature, for 15 minutes, adjustable, or longer, or the temperature difference between the heating water supply and the heating water return is more than 30°F, adjustable, for more than 15 minutes, adjustable. Once one of these conditions occurs, the associated isolation valve is modulated open and proof of flow is verified through the boiler served then energize the lag boiler. The third boiler shall be energized in a similar manner.
3. Turn off the lag boiler(s) after a 30-minute time delay (adjustable) and the temperature difference of the heating water supply and heating water return is less than 10°F, adjustable or the heating water flow drops below the minimum flow of two (2) or three (3) boilers, depending on the quantity of boilers energized. The boiler staging sequence noted previously provides general operating parameters. The associated boiler manufacturer’s boiler management system or boiler staging system shall control the boiler staging and energizing of the associated boilers to provide optimum energy efficiency of the boiler system. In no case shall the boiler management system operate a boiler or boilers below the combined minimum boiler design water flow. Provide ModBus or BacNET interface to boiler management system to provide for communication and control between boiler management system and building Energy Management System (EMS)
4. Alternate which boilers are designated lead and lag after each scheduled shut-down, or a minimum of once every 48 hours, adjustable. If the lead boiler fails start the lag boiler and send an alarm to the BAS/EMS.
5. 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 hot water temperature reset.

a. Provide a supply water temperature sensor to be located in the common heating water supply downstream of both distribution pumps.
b. Outside air reset schedule shall be adjustable and as indicated elsewhere herein.
c. Coordinate the boiler package controls, accessories and wiring with boiler selections by mechanical contractor to ensure a complete and operational system and to eliminate duplication of control components.

6. Boiler firing shall be controlled by boiler equipment furnished flame supervision and burner controls.
7. Through software, start a heating water distribution pump, HWP-1, HWP-2, or HWP-3, when the outside air temperature drops to 35°F, or below, adjustable, independent of other controls, through the Energy Management System, for unoccupied freeze protection under this Section of the Specifications.
8. Provide an audible alarm, hard-wired, in the Mechanical Room in the event of a heating water pump failure (Pump commanded “On” with status of “Off”), or boiler failure (through burner control panel relay), with a silence button under this Section of the Specifications.
9. Contractor to wire and install boiler manufacturer provided outside air re-set and heating water return water temperature sensors as required or provided by the specific boiler manufacturer system.
10. Boilers shall be interlocked with respective combustion air intake dampers such that only the associated section shall open when the boiler is energized and close when turned off. There are three (3) combustion air intake dampers. When all boilers are off all dampers shall be closed.
11. Boiler room shall be equipped with a carbon monoxide detector with a manual reset. The carbon monoxide detector shall be interlocked to disable the burners of the boiler when CO levels rise above 50 PPM. If the CO detector loses power the boilers shall be disabled.

C. Heating Water Distribution System

1. Heating water distribution pumps HWP-1, HWP-2 or HWP-3 shall distribute heating water to the building for heating effect. These pumps shall be alternated by the EMS every 48 hours, adjustable, for even wear of equipment and accessories.
2. 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.
3. Heating water distribution pumps HWP-1, HWP-2 or HWP-3 shall be connected to separate variable frequency drives such that one pump is operated from its respective variable frequency drive, or manual bypass starter, but no two pumps 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.
4. Heating water distribution pumps HWP-1, HWP-2 or HWP-3, shall operate anytime an air handling unit, or group of units or air terminal units are operating and requiring heating and the boiler is called to energize. This includes building warm-up, night set-back, and the freeze protection mode.
5. The lead pump shall be started at minimum pump manufacturer’s recommended speed and ramp up to 90% speed to maintain the system design differential pressure set point. If the pump is unable to maintain the design differential pressure set point, the lag pump shall be started and the lead pump shall reduce in speed to 40% speed. The pumps shall then modulate together to maintain pressure in the system. When the pump speed for both pumps drops below 25%, the lag pump shall be de-energized and lead pump shall be modulated to control system pressure. Only two (2) pumps shall operate at any given time. The third pump is a redundant pump.
6. Provide five (5) differential pressure sensors with transmitters near the extreme ends of the heating water piping, at the heating water coil of AHU-A03, AHU-D02, AHU-N03, AHU-Q03, and AHU-K01. The design differential of greatest demand shall be maintained through the variable frequency drive modulating the speed of the active distribution pump(s). The design differential shall be the combined pressure drop of the control valve and the heating water 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.
7. During heating water distribution system freeze protection, all inactive air handling units and terminal units with heating water valves shall be open to the coil and one (1) heating 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°F, the building is secured

(generally unoccupied); air handling units are generally all off, and not operating in a night set-back or morning warm-up mode.

3.7 SEQUENCE OF OPERATION – INTERMITTENT FAN POWERED VARIABLE AIR VOLUME AIR 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. For series type boxes the fans shall run continuously, drawing air from the plenum and primary air and mixing during the heating mode.

B. Individual space thermostat shall maintain zone temperatures by modulating primary cold air quantities and sequenced staging of fan and operation of two-way or three-way type modulating heating water control valves.

C. On a call for full cooling, the air valve shall be set for maximum design CFM scheduled or indicated.

D. On a fall in space temperature, the air valve shall modulate toward the closed position. The minimum position shall be as scheduled for interior boxes, only where the minimum does not exceed 40% of the design CFM, and 20% for all perimeter boxes. With the air valve at the designated minimum, or closed, position, as applicable, and on a further drop in space temperature during heating mode, 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 set point, typically 72°F, adjustable.

E. Terminals shall be instantaneously energized when the AHU system is energized with the respective air handling unit. Reference other paragraphs for sequence of control for AHU's and for the normal, night set-back, night set-up, morning warm-up and morning cool-down cycle requirements.

F. 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.

3.8 SEQUENCE OF OPERATION – SINGLE DUCT VARIABLE AIR 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 air pressure.

B. Individual space thermostat shall maintain zone temperatures by modulating primary cold air quantities.

C. On a call for full cooling, the air valve shall be set for maximum design CFM scheduled or indicated.

D. On a fall in space temperature, the air valve shall modulate toward the closed position. The minimum position shall be as scheduled.

E. For units with heating water coils, with the air valve at the designated minimum, or closed, position, as applicable, and upon a further drop in space temperature, during heating mode the heating water control valve shall modulate open to maintain space temperature set point, typically 72°F, adjustable.

F. Terminals shall be instantaneously energized when the AHU system is energized with the respective air handling unit. Reference other paragraphs for sequence of control for AHU's and for the normal, night setback, set-up, warm-up and cool-down cycle requirements.

G. 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 – PRIMARY/SECONDARY VARIABLE VOLUME AIR HANDLING UNITS

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.

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 associated with the air handling unit. 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°F. The freezestat shall have a minimum 20 feet long element and shall be sensitive to temperature changes along any 12-inch length. The 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. Coordinate with Fire Alarm installer for integration with smoke detectors.

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. 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.

H. 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.

I. Supply fan capacity shall be controlled by system static pressure sensing stations installed in each supply air duct main branches 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.

J. Supply air duct discharge temperature shall be maintained at 54°F, adjustable, by modulating a control valve on the chilled water coil. Refer to plans for two-way 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°F to 64°F upon a decrease in fan speed, or fan volume, from 50% to 30%, adjustable. 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.

K. Provide interlocks for outside air control as follows:

1. Minimum outside air control shall be maintained throughout the range of the AHU as follows:
    a. When the unit is operated in an occupied mode, the outside air dampers 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 or multiple space mounted carbon dioxide sensor(s) shall be used to regulate the introduction of outside air, to maintain a set point of 1,100 PPM, adjustable, to above the minimum-minimum” value scheduled up to no more than the “minimum-maximum” value scheduled, as limited by the outside air control dampers. For units with multiple space mounted carbon dioxide sensors, the zone of greatest demand (i.e. the highest value) shall control the modulation of the outside air damper for the unit.
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 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 shall consist of the sequenced opening modulation of the separate normally closed (N.C.) O.A. dampers, and the closing modulation of the normally open (N.O.) return air dampers to maintain a 54°F mixed air temperature. Normally closed (N.C.) relief air dampers shall be interlocked to operate in sequence only with the O.A. dampers in operation, or when the space becomes over pressurized as noted elsewhere herein. Should the return air relative humidity rise to 60% R.H., inversely reset the economizer outside air temperature set point downwards to prevent exceeding 60% R.H. in the building.
5. Normally closed (N.C.) relief air dampers shall be interlocked to operate in sequence only with the O.A. dampers in operation, or when the space becomes over pressurized as noted elsewhere.
6. Provide a low limit mixed air plenum thermostat, separate from the system freezestat(s), serpentine capillary sensor, to override the ventilation cycle controls to prevent supply air less than 52°F from entering the system. This shall include modulated closing of the outside air dampers to maintain the set point.
7. Provide for independent control and adjustment for each of the outside air, return, and relief air dampers to allow for maximum flexibility, adjustment, and ability to control minimum outside air flow rates and building pressure.
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 consist of the relief air dampers opening. Once the relief air dampers are opened the associated relief air fan shall be energized and modulated to maintain space pressure. For units with return air fans, the relief air damper shall be modulated proportionately to the position of the outside air damper from the minimum to maximum setting. As the space pressure drops to below set point, the reverse sequence shall occur.

L. 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.

M. 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 boxes 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 only after the respective terminal fan is energized based on a demand for heat. Night set-back sensor set point, adjustable, shall be 55°F. Upon a rise in space zone temperature to 60°F the entire system shall be de-energized. The respective AHU shall remain off in this mode unless the outside air temperature is 30°F, or lower adjustable. In this case the air handler shall energize and the pre-heat coil shall modulate to maintain a minimum 80° F discharge air temperature off the air handler during warm-up mode. Lock out chilled water system, minimum and maximum outside air dampers and relief air dampers and fan during night set-back mode.

N. An optimized start morning warm-up cycle shall be provided to warm the area served by each AHU to 70°F or within 1°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 unless the outside air temperature is 30°F, or lower adjustable. In this case the air handler shall energize and the pre-heat coil shall modulate to maintain a minimum 80°F discharge air temperature off the air handler during warm-up mode. Lock out chilled water system, minimum and maximum outside air dampers and relief air dampers and fan during night set-back mode.

O. 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°F, or within 1°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°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°F, adjustable.

R. The pre-heat coil shall be energized and modulate a 2-way or 3-way valve to control discharge air temperature off the unit whenever the outside air temperature is below 50°F., and the spaces are calling for heating. The pre-heat coil shall modulate to maintain a discharge temperature of 60°F, adjustable.

S. When O.A. temperature is sensed below 25°F., adjustable, close the O.A. dampers and fully open the return air dampers. For units with relief air fans, the relief air fan shall not be energized until the relief air dampers are modulated open and the space pressure rises above setpoint.

3.10 SEQUENCE OF OPERATION – SINGLE ZONE VARIABLE VOLUME AIR HANDLING UNITS

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.

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 associated with the air handling unit. 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°F. The freezestat shall have a minimum 20 feet long element and shall be sensitive to temperature changes along any 12-inch length. The 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. Coordinate with Fire Alarm installer for integration with smoke detectors.

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. 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.

H. 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.

I. Supply fan capacity shall be controlled by system static pressure sensing stations installed in each supply air duct main branches 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.

J. For cooling mode, the supply air duct discharge temperature shall be maintained at 54°F, adjustable, by modulating a control valve on the chilled water coil. Refer to plans for two-way 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°F to 64°F upon a decrease in fan speed, or fan volume, from 50% to 30%, adjustable. 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.

K. For dehumidification mode, when the relative humidity level for the zone served by the unit cannot maintain 60% R.H. by means of resetting cooling discharge temperatures, then the re-heat heating water coil control valve shall modulate to reheat the air so that the discharge air relative humidify is reduced to maintain a 50%R.H. (adjustable) set-point in the space.

L. For heating mode, the supply air duct discharge temperature shall be maintained at 85°F, adjustable, by modulating a control valve on the pre-heat heating water coil. Refer to plans for two-way 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 pre-heat heating water 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 decrease discharge air temperature from 85°F to 60°F upon a decrease in fan speed, or fan volume, from 50% to 30%, adjustable.

M. The pre-heat coil shall be energized and modulate a 2-way or 3-way valve to control discharge air temperature off the unit whenever the outside air temperature is below 50°F., and the spaces are calling for heating. The pre-heat coil shall modulate to maintain a discharge temperature of 85°F, adjustable.

N. Provide interlocks for outside air control as follows:

1. Minimum outside air control shall be maintained throughout the range of the AHU as follows:
    a. When the unit is operated in an occupied mode, the outside air dampers 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 or multiple space mounted carbon dioxide sensor(s) shall be used to regulate the introduction of outside air, to maintain a set point of 1,100 PPM, adjustable, to above the minimum-minimum” value scheduled up to no more than the “minimum-maximum” value scheduled, as limited by the outside air control dampers. For units with multiple space mounted carbon dioxide sensors, the zone of greatest demand (i.e. the highest value) shall control the modulation of the outside air damper for the unit.
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 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 shall consist of the sequenced opening modulation of the separate normally closed (N.C.) O.A. dampers, and the closing modulation of the normally open (N.O.) return air dampers to maintain a 54°F mixed air temperature. Normally closed (N.C.) relief air dampers shall be interlocked to operate in sequence only with the O.A. dampers in operation, or when the space becomes over pressurized as noted elsewhere herein. Should the return air relative humidity rise to 60% R.H., inversely reset the economizer outside air temperature set point downwards to prevent exceeding 60% R.H. in the building.
5. Normally closed (N.C.) relief air dampers shall be interlocked to operate in sequence only with the O.A. dampers in operation, or when the space becomes over pressurized as noted elsewhere.
6. Provide a low limit mixed air plenum thermostat, separate from the system freezestat(s), serpentine capillary sensor, to override the ventilation cycle controls to prevent supply air less than 52°F from entering the system. This shall include modulated closing of the outside air dampers to maintain the set point.
7. Provide for independent control and adjustment for each of the outside air, return, and relief air dampers to allow for maximum flexibility, adjustment, and ability to control minimum outside air flow rates and building pressure.
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 consist of the relief air dampers opening. Once the relief air dampers are opened the associated relief air fan shall be energized and modulated to maintain space pressure. For units with return air fans, the relief air damper shall be modulated proportionately to the position of the outside

air damper from the minimum to maximum setting. As the space pressure drops to below set point, the reverse sequence shall occur.

O. When O.A. temperature is sensed below 25°F., adjustable, close the O.A. dampers and fully open the return air dampers. For units with relief air fans, the relief air fan shall not be energized until the relief air dampers are modulated open and the space pressure rises above setpoint.

P. Specialized Operations

1. Kitchen Operations — AHU-M01, AHU-L01, and DCKV Systems for Kitchen Exhaust Fans

a. Coordinate with the demand control kitchen ventilation systems (DCKV) for each hood and its associated exhaust fan (KEF-M02, KEF-M03, KEF-M04, KEF-M05, & KEF-M06).
b. Outside air dampers shall modulate to ensure space pressurization in the kitchen does not become negative.

1) Outside air dampers for AHU-M01 shall modulate open as kitchen exhaust fans energize and modulate air speed.
2) When the outside air dampers for AHU-M01 are open to their maximum position and pressurization in the kitchen becomes negative, then if AHU-L01 is not energized, it shall energize and its outside air damper shall modulate to reduce pressurization in the kitchen.

2. Athletics Operations — for units serving athletics area with large volumetric flow rates of exhaust air, outside air dampers shall modulate to ensure the pressurization of the building does not become negative.

Q. During the normal “occupied” mode of operation 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.

R. 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 control the operation of the AHU during this mode. The AHU shall seek to satisfy the heating set point for the mode of operation. The control valve on the pre-heating coil shall modulate to satisfy the temperature sensor set point after the AHU is energized based on a demand for heat. Night set-back sensor set point, adjustable, shall be 55°F. Upon a rise in space zone temperature to 60°F the AHU shall be de-energized. The respective AHU shall remain off in this mode unless the outside air temperature is 30°F, or lower, adjustable. In this case the air handler shall energize and the pre-heat coil shall modulate to maintain a minimum 80° F discharge air temperature off the air handler during warm-up mode. Lock out chilled water system, minimum and maximum outside air dampers and relief air dampers and fan during night set-back mode.

S. An optimized start morning warm-up cycle shall be provided to warm the area served by each AHU to 70°F or within 1°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, the AHU 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 unless the outside air temperature is 30°F, or lower adjustable. In this case the air handler shall energize and the pre-heat coil shall modulate to maintain a minimum 80°F discharge air temperature off the air handler during warm-up mode. Lock out chilled water system, minimum and maximum outside air dampers and relief air dampers and fan during night set-back mode.

T. 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.

U. 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°F, or within 1°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.

V. A night set-up mode shall occur when any space temperature sensor served by the AHU rises above 84°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°F, adjustable.

3.11 SEQUENCE OF OPERATION - PACKAGED ROOFTOP AIR CONDITIONING UNITS - SINGLE ZONE UNITS

A. The direct digital control system shall monitor and control each rooftop A/C unit. Electronic room temperature and relative humidity sensors shall, through a local terminal unit DDC Controller, one per unit, control its DX cooling stages of cooling as noted on equipment schedule), hot gas reheat coils for all units, heating (stages of heating as noted on equipment schedule), and air-side economizer capability (only where scheduled), outside, return and relief/exhaust air dampers 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°F dead band between set points, adjustable up to 5°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. For those units so designated on the Mechanical Drawings and in the Schedules, provide a wall mounted carbon dioxide sensor which shall modulate, via an analog signal to the rooftop unit, the return and outside air dampers, in sequence, to maintain a maximum level of 1,100 Parts Per Million (PPM), adjustable.
    a. The outside air dampers shall remain closed in the occupied space, except when the unit is operated in the normal occupied mode, in which case the outside air dampers shall open to the minimum-minimum position scheduled.
    b. Once the carbon dioxide set point of 1,100 PPM, adjustable, is reached; the outside air damper shall modulate further open to maintain this set point but in no instance shall it open beyond the minimum-maximum position scheduled.
    c. The return damper shall modulate from its fully open position to the corresponding sequenced position with the outside air damper, which shall go from its fully closed position up to its maximum-minimum value scheduled.
    d. The return air damper shall have a software safety interlock that will not allow it to go past 50% closed during mechanical cooling.
    e. Carbon dioxide sensor control shall be locked out when the unit enables the economizer cycle.
5. 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 73°F (adjustable).
    a. On a rise above set point the 1st stage of cooling, first compressor, shall be energized.
    b. For 2 stage or multi-stage units the second compressor will only be energized upon a further rise above set point and when the first compressor has been on longer than 5 minutes, adjustable.
    c. On a decrease in demand for cooling the second stage compressor shall be cycled off.
    d. On a further decrease in space temperature, the first stage compressor shall be cycled off.

e. Each stage of cooling shall have a minimum off time of approximately 5 minutes (Variable as determined through PID loop control).
f. For inverter driven or digital scroll compressors, the compressor shall modulate to maintain a discharge air temperature of 55°F, adjustable, and the ECM fan motor shall modulate to control space temperature.

6. The space relative humidity (R.H.) sensor shall, through its DDC controller output signal, cause the unit to go into the dehumidification 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.
   a. 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.
   b. Provide R.H. sensors for all units.
   c. 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. The unit shall go into alarm until reset.
7. Humidification
   a. For those units whose systems have humidification systems integrated with them, humidity levels shall be maintained at a 60%R.H. set point (adjustable).
   b. Humidifier controller shall be integrated with the BAS to operate in coordination with the RTU so as to maintain humidity at 60%R.H. (adjustable) when the humidity levels begin to drop below 50% R.H. (adjustable).
8. The heating temperature set point shall be 72°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.
   a. The cooling system and hot gas reheat shall be de-energized while heating with natural gas.
   b. A supply air high limit control feature shall be provided to prevent the supply air temperature from raising above 90°F by overriding and de-energizing the heat as required.
   c. 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°F, adjustable.
   d. For 2-stage or multi-stage heating units, the furnace heating sections will stage on as required to meet demand in a stable fashion.
9. When the outdoor air temperature is below 65°F, adjustable, the economizer dampers shall modulate, in sequence, as required, to satisfy the space temperature sensor's cooling set point.
   a. If the economizer cannot satisfy the space temperature set point (100% open) then energize the cooling system of compressor(s), as required.
   b. No enthalpy or return air comparison economizers allowed.
   c. Should the space relative humidity rise to 60% RH, adjustable, while in the economizer mode inversely reset the outside air dry bulb set point downward until the relative humidity drops to below 60% R.H. (use a 4% R.H. differential).
   d. Carbon dioxide sensor control shall be disabled when the unit is in the economizer mode.
10. An evaporator fan differential pressure switch 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.
11. Space temperature sensors will also be used to operate the units in the unoccupied modes of operation.
12. During the optimized start morning "warm-up" mode (winter), the unit supply air 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.
    a. During this mode the minimum outdoor air damper will be closed.

b. When the space reaches warm-up set point, 1°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.
c. Warm-up shall occur not more than once each day.
d. The discharge air temperature high limit control sequence shall remain in control during the morning warm-up mode.

13. During the optimized start morning cool-down (summer) mode, the unit’s supply air 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.

    a. During this mode, the outdoor air damper will be closed.
    b. When the space reaches cool-down set point, 1°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.
    c. Cool-down shall occur not more than once each day.

14. During the night set-forward and night set-back modes the equipment will be cycled as required to maintain those set points.

    a. On at 85°F. and off at 80°F, adjustable, for set-forward
    b. On at 55°F and off at 60°F, adjustable, for night set-back
    c. The outdoor air dampers shall be closed in both of these modes.
    d. The discharge air temperature high limit control sequence shall remain in control during the night set-back mode

15. Should the space temperature drop to 1°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. Send an alarm to the EMS when this occurs.
16. The rooftop units furnished with factory assembled modulating air-side economizers with digital controller 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.
    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 dampers, above minimum setting, 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 economizer interface as described herein. Coordinate these requirements with each specified equipment manufacturer.
    d. Provide for low supply air temperature control, which shall prevent the supply air temperature from dropping below 53°F, adjustable, when the unit is operated in the economizer mode. Override the economizer dampers as needed to achieve this low limit condition. Coordinate this provision with each specified equipment manufacturer.
    e. Economizers shall be energized on a drop to below 65°F ambient, adjustable. Should the space relative humidity rise to 60% R.H, or higher, adjustable, the economizer control set point shall be lowered as required to prevent the space relative humidity from rising to above 60% R.H.

B. Provide a condensate overflow moisture sensor or float switch in upper portion of drain pan.

    1. When the sensor or float detects excess water in the pan, the RTU shall de-energize and an alarm shall be sent to the EMS.
    2. All RTUs shall be provided with this condensate overflow protection.

C. Multiple sensors shall be provided for some roof top units as shown on the Mechanical Drawings.

1. The primary sensor shall control heating and cooling set point, unless the space temperature in secondary space is greater/less than 2.5°F (adjustable) difference from set point.
2. When this occurs (the space temperature in secondary space is greater/less than 2.5°F, adjustable, difference from set point), the secondary sensor shall control the heating set point until such time as it is within 1°F (adjustable) of space set point.
3. Once this temperature is reached, the primary space temperature sensor shall return to being the control sensor for the unit.
4. For units with more than two (2) sensors, the secondary and tertiary sensors shall be averaged together and that value shall be used as the secondary value in a primary-secondary scenario.

D. Units serving spaces with overhead doors

1. Units serving spaces with overhead doors shall be integrated with sensors detecting that the overhead door is open.
2. When an overhead door has been open for 15 minutes (adjustable) the RTU shall de-energize.
3. When the overhead door has been closed, the RTU shall be permitted to energize.
4. Provide an override feature for this functionality.

3.12 SEQUENCE OF OPERATION – ELECTRIC UNIT HEATERS

A. Electric unit heaters shall be controlled by manufacturer furnished thermostats set at 68°F (adjustable). On a fall in temperature below 68°F., the unit heaters shall be energized. On a 2°F, adjustable, rise above set point, the heater will be de-energized.

B. Mount thermostats, under this Section of Specifications, on wall where indicated on the Drawings. Coordinate location with Architect.

PART 4 - EXECUTION

4.1 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.

4.2 TEMPERATURE SENSORS

A. Space wall mounted sensors with manual adjustment shall be installed 48” inches above finished floor to comply with ADA, unless indicated or approved otherwise by the Architect, Owner, or Owner’s Representative.

4.3 TEST, ADJUST, AND BALANCE SUPPLEMENTARY PROVISIONS

A. Furnish and install capabilities at each control device that can test the controls. This is to include the actual input and output signal of all 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 thermo-wells and supplementary test wells or plugs. Verify acceptable locations with TAB Firm. Then mark locations and coordinate with others to install devices under Section 23 21 13 scope of work.

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 thermo-wells 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 herein.

F. Under this section of the specifications, provide all duct pressure sensing taps, test ports, sensors, wiring/cabling, etc., to be connected to the Energy Management System to include all points necessary for the sequence of operations specified herein.

4.4 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, RTU, or piece of equipment.

C. Separate monitoring only control point controllers are desired in lieu of adding these to dedicated equipment controllers.

D. Each DDC controller used for larger equipment control and is a main central building controller shall have their own real time clocks.

END OF SECTION

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SECTION 23 21 13

HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 01 - 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 Division 01 and 23 for all piping materials to be used for each system as well as valves and hydronic specialties as specified herein.

B. Shop Drawings:

1. Submit in accordance with Division 01 and Section 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".
5. To obtain BIM files for this purpose, a “Release of Liability” form must be signed prior to release of files.
6. Fully coordinate all piping shop drawings with sheet metal shop drawings and other trades.
7. 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. Products and materials shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

C. Storage and protection of materials shall be in accordance with Section 23 05 00.

D. Take special precautions to protect materials and products (including, but not limited to control valve internals, hydronic specialties, and other appurtenances) from construction dirt and debris. If materials and products are stored on site cover and protect until just prior to installation but in no case shall materials and products be unprotected for more than 48 hours.

E. Openings in piping systems 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. General

1. In general, the following listed materials shall be used in fabricating the piping systems.
2. 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.
3. 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.

B. Chilled and Heating Water Lines

1. Sizes 2" and smaller:

a. Schedule 40 black steel pipe conforming to ASTM A-53, Type “F”
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. Sizes 2 ½” and larger:

a. Schedule 40 black steel pipe, Grade “B”, Type “ERW”
b. Piping 12" and larger in Central Plant Chiller and Boiler Rooms shall be Schedule 40 in wall thickness.
c. Piping 12" and larger outside the Chiller and Boiler Plant may be standard weight piping.

C. Condenser Water Lines

1. Sizes 2" and smaller: Schedule 40 black steel pipe conforming to ASTM A-53, Type “F”
2. Sizes 2 ½” and larger: Schedule 40 black steel pipe Grade “B”, Type “ERW, for all sizes 2-1/2" and larger.
3. Atmospheric Relief Lines:

a. Schedule 40 black steel pipe
b. Or Type "L" copper

D. Drains:

1. Condensate drains from Air Handling Units, Fan coil units, Pump Bases, strainer blow-offs, backflow preventors, and compression tanks:
    a. Hard drawn copper Type "M" (for all sizes)
    b. Hard drawn copper Type DWV (for 1-1/4" and larger)
2. Drains from appurtenances installed in copper lines shall be of Type "L" hard drawn copper tubing.
3. Other drains shall similarly match the piping system materials.

E. Miscellaneous Lines:

1. 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.
2. Drains from appurtenances installed in copper lines shall be of Type "L" hard drawn copper tubing.
3. Drains from air vent valves installed in steel piping systems shall be Schedule 40 black steel pipe.
4. Other miscellaneous lines shall similarly match the piping system materials.

F. Chemical treatment piping:

1. 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.
2. Final connections to the main system shall be Schedule 40 black steel or Type "L" hard drawn copper.

G. Refrigerant Piping:

1. Refrigerant piping shall be Type L, ACR cleaned and capped, hard drawn copper with 15% Silfos Solder joints.
2. Copper line set tubing material is only permitted for split DX mini-split (ductless) systems only and shall not be used for air handling units that have ducted supply. Tubing shall be equal to Mueller Streamline Copper Tube.
3. Only “Sil-Fos” solder joints shall be used for fitting fabrication.
4. Miscellaneous lines for pilot, bleed, control, sampling, equalizing, and similar auxiliary lines shall be fabricated of the same material used by the system to which they are connected in each case.

H. Atmospheric Relief Lines: Type “L” copper.

I. All piping materials shall be manufactured in the United States.

J. Steel pipe

1. 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.
2. Piping 2" and smaller shall be manufactured by:
    a. LeClede
    b. Sawhill
    c. Wheatland
3. Piping 2-1/2" and larger shall be manufactured by:
    a. Tex-Tube
    b. Paragon
    c. U.S. Steel
    d. Wheatland
    e. Armco
4. Unless otherwise specified, all pipe shall be Schedule 40 of ASA Standard B36.10.

2.2 PIPE FITTINGS

A. 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.

B. Welded Fittings:

1. 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.
2. 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:
    a. 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 either of the following:
        1) Shaped nipples
        2) Bonney Weldolets
        3) Grinnell Weldolets
        4) Threadolets as required by the class of fabrication.
    b. The following are not permitted.
        1) Mitering of pipe to form elbows will not be permitted.
        2) Notching of straight runs to form tees will not be permitted.
        3) Any similar construction to these will not be permitted.
3. Welding fittings shall be:
    a. Weldbend Corporation
    b. Tube Turn
    c. Hackney
    d. Or approved equals.
4. Welding and fittings shall have the same bursting pressure as pipe of the same size and schedule.
5. All elbows shall be the long radius type unless noted otherwise.

C. Screwed Fittings in Steel Lines:

1. 150 lb. black malleable iron banded pattern screwed fittings
2. Approved Manufacturers:
    a. Grinnell Company
    b. Crane Company
    c. Walworth Company
3. All screwed fitting elbows shall be the long radius type unless noted otherwise.
4. It is intended not to use threaded steel piping.

D. Fittings for Copper Pipe

1. Approved Manufacturers:
    a. Chase Sweat Fittings
    b. Nibco
    c. Elkhart
    d. Mueller Brass Company's "Streamline"
2. Fittings for copper pipe shall be solder fittings.
3. Drainage (DWV) type fittings shall be used wherever possible in drainage systems. This includes condensate drain piping where drainage (DWV) type fittings shall be used.
4. All solder for copper pipe shall be 95-5 (95% tin, 5% antimony), Silfos or Eutectic No. 180F.
5. All piping shall be installed according to the manufacturer's instructions.

6. All joints shall be thoroughly cleaned before connecting.
7. Silfos solder shall be used on all refrigerant piping.
8. All elbows shall be the long radius type unless noted otherwise.
9. Press fittings may be used for drainage systems that are not pressurized.

    a. Sealing elements for press fittings shall be EDPM and shall be factory installed with a leakage path feature that will assure leakage of liquid from inside the engineered system past the sealing element of an unpressed connection (a quality control mechanism).
    b. Acceptable Manufacturers:

        1) Viega
        2) Similar approved equals

    c. Where press fittings are used, contractor shall provide the owner with one (1) press tool for pipes sizes ½" to 3".

E. Miscellaneous Fittings:

1. Provide all reducers, increasers, adapters, bushings, etc., as required to properly inter-connect the various items, to change sizes, etc.
2. Steel fittings shall be used in steel lines.
3. Copper and red brass fittings shall be used in copper lines.

F. All piping materials and fittings shall be manufactured in the United States.

2.3 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 by the following.

1. Weldbend
2. Tube Turn
3. Hackney
4. or approved equals

2.4 GASKETS

A. For all water filled piping systems operating under normal conditions, install the appropriate gaskets between flanges of all flanged joints.

B. Where gaskets are used with brass or bronze flanges, or with flat face ferrous flanges, they shall be full face type. All other flanges shall be ring gaskets properly cut to fit within the inside edges of the bolts.

C. Gaskets in all water filled lines shall be Garlock BLUE-GARD® Compressed Gasketing, Style 3000, or approved equals only.

D. Gaskets shall generally be made of Wire Insertion Red Rubber Sheet Packing, minimum 1/16" thick.

E. Systems operating with other than water and any systems operating at temperatures and pressures beyond the levels specified herein, shall only use special materials suitable for the duty as recommended by the gasket manufacturer. Submit appropriate technical performance criteria for all gaskets for each system encountered.

F. The gaskets furnished under this section of the specifications shall comply with the following limits:

1. Pressure Limit: 1,000 PSIG (70 bar).
2. Maximum Temperature Limit: 700°F (370°C).
3. Ideal Operating Temperature: 400°F (205°C).
4. P x T Limit: 350,000* (12,000); 1,000 PSIG (70 bar) and maximum temperature of 350°F (180°C).

2.5 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:

1. EPCO
2. Watts
3. Zurn
4. Mueller Streamline

2.6 PIPE HANGERS

A. Acceptable Manufacturers

1. Pipe hangers, except for fire protection types, shall be as manufactured by Anvil International, Inc. and be of a type suitable for each use.
2. Approved equals by

a. Mason Industries, Inc.
b. B-Line
c. Erico Caddy
d. PHD Manufacturing, Inc.

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.

C. For cast iron plumbing piping four inches (4") and larger, use only Anvil Fig. 590 steel clevis hanger.

D. Heating and air conditioning piping (chilled, heating 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. Condensate drain piping 3/4" in size up to and including three inches (3"), shall use Anvil Fig. 260, adjustable clevis hangers. Hangers shall be sized to be on the outside of the insulation.

H. For HDPE piping, use Eaton B-Line B3106 Vee Bottom Clevis Hanger or equivalent by listed manufacturers. Include vee channel support for plastic pipe similar to Eaton B-Line B3106V (or equivalent by listed manufacturer). Hanger and support channel shall be appropriately sized for the supported pipe size.

I. 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

J. 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.

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') 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 or Hilti.

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. 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 or Armacell Insuguard. Inserts should be provided to avoid damage to the insulation and maintain thermal barriers. See also the insulation specification section 23 07 00.

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 Division 09.

T. For pipe sizes 8" and under use Anvil Fig. #93 and 94 beam clamps.

U. For pipe sizes 10" through 18" use Anvil Fig. #66 in the “U” position.

2.7 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 ensure 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.

2.8 STORM SHELTER PIPE PENETRATION PROTECTION – WALL SHROUD

A. Where pipes penetration openings storm shelter walls exceed the ICC-500 maximum opening size the opening in the wall shall be protected. The opening may be protected by an ICC-500 rated wall shroud. Refer to drawings for use of ICC-500 rated wall shrouds — location, number of pipes, size of shroud.

B. Wall shroud shall be engineered with a two-point deflection for compliance with ICC-500 requirements.

C. Wall shroud shall be third-party tested to meet ICC-500 and FEMA performance requirements, including projectile impact and labeling.

D. Wall shroud shall be constructed of 3/16” carbon steel or Schedule 40 steel which shall be coated.

E. Shroud size shall be as required to full cover the opening and accommodate the size and number of pipes routing through the opening.

F. Wall shroud shall be equal to RHP Cyclone Model CWS.

2.9 VALVES

A. General Requirements

1. 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.
2. All valves shall be so located as to be readily accessible for operation and maintenance.
3. 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.
4. 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.
5. All valves shall be designed for re-packing under pressure when fully opened and shall be equipped with packing suitable for the service.

6. 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.
7. Except where special valves are specified elsewhere herein or as required by special conditions or class of work, valves shall be equivalent to the products listed herein.
8. Provide chain operators on all gate and 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".

B. Gate Valves

1. General

a. All gate valves 2" and smaller shall be Class 125SWP and 200 PSI CWP rated for up to 200 Deg.F. and be bronze construction.
b. All valves 2-1/2" and larger shall be Class 125SWP and 200WOG rated for 200°F, be of the flanged design, be made of cast iron with bronze trim, and have an outside screw and yoke design.
c. Valves shall have rising stem, screwed bonnet or union bonnet, solid wedge and manufactured in accordance with MSS-SP-80.
d. Body, bonnett and wedge

1) 2” and smaller: ASTM B-62 alloy
2) Larger than 2”: ASTM A126, Class B, cast iron

e. All valves shall have ductile or malleable iron handwheels.
f. Stems shall be made of dezincification resistant silicon bronze ASTM B-371 or low zinc alloy B-99.
g. All valves shall be supplied with non-asbestos packing, amarid fibers or approved equal.
h. Where higher operating pressures approach 150 psi, Class 150 Union bonnet valves of similar construction shall be used.

2. Class 125 valves 2" and smaller shall be one of the following:

a. Nibco - T/S111.
b. Crane - 428/1330.
c. Jenkins - 810J.
d. Hammond IB640.
e. Milwaukee 148.

3. Class 125 valves 2-1/2" and larger shall be one of the following:

a. Nibco - F-617-0.
b. Crane - 465 1/2.
c. Jenkins - 454J.
d. Hammond IR1140.
e. Milwaukee 2885A.

4. Class 150 valves shall be one of the following:

a. Nibco - T/S134.
b. Crane - 431UB.
c. Jenkins - 47CUJ.
d. Hammond IB629/IB648.
e. Milwaukee 1169/1151.

C. Globe Valves

1. General

a. All globes valves 2" and smaller shall be Class 150 rated to 200°F or Class 300 rated up to 300°F.

b. All valves 2-1/2" and larger shall be Class 125WP and 200WOG rated for 200°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.
c. Valves shall have rising stem, screwed or union bonnet and manufactured in accordance with MSS-SP-80.
d. Body and bonnet shall be manufactured of ASTM B-62 alloy or ASTM B-61 alloy.
e. All valves shall have ductile or malleable iron handwheels.
f. Stems shall be made of dezincification resistant silicon bronze ASTM B-371 or be low zinc alloy B-99.
g. All valves shall be supplied with non-asbestos packing, amarid fibers or approved equal.
h. Where higher operating pressures approach 300 PSI, Class 300 Union bonnet valves of similar construction shall be used.

2. 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.

3. 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.

4. Class 300 valves shall be one of the following:

a. Nibco - T-276-AP.
b. Crane - 382P.
c. Jenkins - 592J.
d. Hammond IB444.
e. Milwaukee 593A.

D. Check Valves

1. Non-Slam Check Valves

a. Check valves in pump discharge lines shall be flanged non-slam type silent check valves.
b. Valves shall have a cast-iron body and be bronze fitted with stainless steel springs.
c. Valves shall be rated for 125 PSIG WOG.
d. Acceptable products:

1) Nibco - F-910-B Series.
2) Combination Pump Valve (CPV) Manufacturing, Inc.- 20D Series.
3) APCO - 600 Series.

2. Swing Check Valves (2” and smaller)

a. 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°F, have bronze ASTM B-62 bodies with bronze discs.
b. Acceptable products:

1) Nibco - T/S-413-B.
2) Crane - 37 or 1340.
3) Jenkins - 4037J or 997AJ.

4) Hammond - IR1124.
5) Milwaukee - 2974A.

3. Swing Check Valves (larger than 2")

a. Swing Check valves larger than 2" shall be the swing-type manufactured in accordance with MSS-SP71, be Class 125 rated for 200°F, be flanged, have ASTM A126, Class B, cast iron bodies with bronze trim, and have non-asbestos gaskets.
b. Acceptable products:

1) Nibco - F-918-B.
2) Crane - 373.
3) Jenkins - 588J.
4) Hammond - IB904.
5) Milwaukee - 509.

E. Plug Valves

1. Provide plug valves where indicated, at "all water balance stations" and at all pump discharges where detailed on the Drawings.
2. In no case shall butterfly or ball valves be substituted for plug valves where plug valves are indicated on the Drawings.
3. Valves shall be flanged-type, 2-1/2" and larger, and threaded 2" and smaller.
4. Plug valves 4" and smaller shall be equal to DeZurik (or SMG) Series 400 eccentric plug valves with cast iron bodies.
5. Plug valves over 4" in size shall be equal to DeZurik (or SMG) Series 100 eccentric plug valves with cast iron bodies.
6. 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.
7. Valves over 4" shall have cast iron bodies with stainless steel plugs and bearings.
8. All plugs shall have resilient faces rated for water temperatures up to 250°F and stem seals meeting the same temperature rating.
9. For general chilled and heating water applications, elastomeric coating shall be EPDM.
10. Furnish lever operator for all valves except at water coils of terminal units where snap-on plastic caps shall be furnished.
11. All valves shall have adjustable memory stops with plastic drip caps.
12. Plug valves shall be furnished with drilled and tapped 1/8" openings for pressure gauge connections at both upstream and downstream sides.
13. Plug valves shall be bubble tight with 150-pound differential pressure across the seat.
14. An indicator shall be included to show valve position.
15. All flanged plug valves shall have bolted bonnets.
16. All valve seats shall be welded in nickel for plug valves over 4" in size.
17. Plug valves shall be as manufactured by:

a. DeZurik (or SMG).
b. W-K-M.
c. Rockwell-Nordstrom.
d. Milliken.

F. Butterfly Valves

1. Contractor shall furnish butterfly valves where indicated on the Drawings.
2. Butterfly valves may be provided in lieu of gate valves where gate valves are shown.
3. Generally, all isolation valves in chilled water, heating water, and condenser water lines 2-1/2" and larger shall be the butterfly type.
4. 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.
5. Liner shall generally be resilient EPDM with brass bushings and collar.
6. Liner and seats shall be rated for 225° F at 150 PSIG.
7. Valves 2-1/2" and larger shall have lug bodies and resilient seating or have a resilient faced plug.
8. 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.

9. 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.
10. 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.
11. Provide two-inch (2") extension necks for insulated lines.
12. All valves shall be lined or coated such that no steel or metal is in direct contact with the water.
13. 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.

G. Ball Valves

1. Where shown on the Drawings, Contractor shall provide ball valves.
2. Ball valves may be provided in lieu of gate valves.
3. In chilled water, heating water, condenser, domestic cold and hot water lines 2" and smaller, Contractor shall furnish ball valves without exception as follows.
4. 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.
5. Ball valves shall be full port design with stainless steel ball and stem.
6. All ball valve body pieces and stems shall be manufactured from a dezincification resistant material with less than 15% zinc.
7. 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.
8. Provide memory stops where used for balancing or as shown and where detailed.
9. Provide extended lever handles for all valves installed in insulated lines.
10. Approved ball valve manufacturer and 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).

2.10 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 15, 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 15 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.

2.11 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.

2.12 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.

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. Refer to Division 22 for domestic water piping requirements.

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.

F. Equivalent as manufactured by the following will be considered:

1. Grinnell.
2. Crane.
3. Lesley.
4. McAlear.
5. Keckley.
6. Mueller.
7. Nibco.

2.13 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, evaporator, and condenser.
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.

C. Needle valves shall be a Weksler AV32, AV34, or BBV4.

D. Cocks

1. 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.
2. Also provide and install all special cocks required such as pet cocks, gauge cocks, etc.

E. 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.

F. 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, evaporator, and condenser.
3. At the inlet and outlet of each pressure reducing station.
4. At other points indicated on the Drawings.

G. 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.

H. 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° 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.

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

J. Cocks and gauges shall be manufactured by:

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

2.14 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° 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.

2.15 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 / Peterson Equipment Company
2. Autoflow.
3. Flowset.

2.16 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. Provide a label that clearly identifies the design water flow rate limit, in GPM, for each flow control valve.

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 specification paragraph on 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.
3. Nexus.

H. It is the intent of this specification to require single devices which will be field piped per Schematics shown on the Drawings. Pre-piped assemblies or factory fabricated combinations of multiple piping accessories are not allowed. Pre-assembled or factory-fabricated combinations of manufacturer furnished coil piping accessories are not acceptable. Consideration will be given to shop-assembled coil connection packages done by the mechanical contractor prior to sending out to job site with engineer acceptance.

2.17 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

1. Watts
2. Klipfel
3. McAlear
4. McDonnell and Miller.

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

2.18 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°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° 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° 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 PIPING THROUGH STORM SHELTER WALLS

A. Coordinate the installation of pipes routing through storm shelter walls with architecture, structure, and wall installers so that opening sizes are provided accurately and openings are protected.

B. Where pipes route through shelter walls and are protected by an ICC-500 rated wall shroud, refer to manufacturer's installation instructions. Follow installation instructions and coordinate those instructions with wall installers.

1. Ensure openings are completely protected.
2. Ensure wall shroud is properly secured to wall.
3. Refer to architectural requirements for fire stopping and other annular fill requirements at the penetration.

3.3 REFRIGERANT PIPING CONNECTIONS

A. Install condensing units level on concrete pads or roof rails 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.

F. Piping shall be Type "L" copper. ACR cleaned and capped. All fittings shall be cleaned and degreased before use.

G. 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.

H. 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.

I. 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.

J. 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.

3.4 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.

3.5 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 Division 31. Refer also to geotechnical report.

3.6 FLASHINGS

A. Flash around all pipes passing through the roof with sheet lead, as specified in Division 07, 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 Division 07.

3.7 PIPE INSULATION INSERTS AND SHIELDS

A. Provide insulation inserts and insulation shield at pipe hanger locations as specified elsewhere herein and detailed on drawings. Shield shall be full half cylinders equal to Grinnell Fig. 167. Armacell ArmaFix EcoLight and Insuguard are also acceptable in condensate and refrigerant lines where closed cell foam type insulation is used.

B. Refer to Section 23 07 00, Insulation.

3.8 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.

3.9 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. Refer to Division 22 specifications.

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. Refer to Division 22 specifications.

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.

3.10 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 Division 07 and Section 23 05 00.

3.11 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.

3.12 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 Division 09.

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

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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 condenser water at no higher than 250°F or lower than 10°F.

D. Pumps shall be factory assembled into packages as specified herein and as detailed on the drawings.

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:

1. Submit manufacturer's descriptive literature and installation instructions together with clear pump curves in accordance with Section 23 0500.
2. Submittals to include pump and motor efficiencies at full load and at 60 Hertz.
3. For variable speed applications submit on the same at 15 Hertz, 30 Hertz and 45 Hertz.

B. Shop Drawings: Submit in accordance with Section 23 0500.

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 motor that meets the scheduled horsepower, speed, voltage, and enclosure design. 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 manufacturer. 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°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:

1. Coupling guard shall be all metal and fastened to baseplate.
2. Guard shall be removable.
3. 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 regreaseable.

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.

2.2 DOUBLE SUCTION PUMPS

A. Double suction pumps shall be bronze fitted, horizontally split case 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 re-greaseable 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 re-greaseable 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. Approved pump manufacturers:

1. Xylem: Bell & Gossett
2. Armstrong
3. PACO
4. TACO

2.3 END SUCTION PUMPS (CENTRIFUGAL 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. Pumps shall be frame mounted type.

C. Each pump and motor shall be mounted on a common baseplate and shall be connected through a spacer type flexible coupling.

D. The casing bearing bracket, bearing cover and gland shall be of cast iron, ASTM A-48, Class 25A.

E. The shaft shall be of stainless-steel construction.

F. 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.

G. The 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.

H. Seals shall be John Crane, Type 21, or equivalent, mechanical shaft seals.

I. Bearings shall be grease-lubricated ball type, selected to the carry radial and thrust loads required based on the scheduled requirements.

J. A bearing assembly shall support the shaft via two heavy-duty re-greaseable 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 re-greaseable 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.

K. 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.

L. Approved pump manufacturers:

1. Xylem: Bell & Gossett
2. Armstrong
3. PACO
4. TACO

2.4 IN-LINE CIRCULATING PUMPS

A. Pumps shall be of the in-line, direct coupled, single stage design with attached motor. Pump models shall be furnished as shown on the Plans and installed in accordance with the manufacturer's recommendations. Each pump shall be capable of delivering the scheduled gallons per minute when operating at the scheduled total developed head of feet. The pump shall be capable of operating continuously at temperatures from 5°F to 250°F (-15°C to 121°C) with working pressures of 145 psi (10 Bars). Pump shall have flanges and be ANSI B16.1, 125-pound flat face, rated.

B. Pump body shall be of Class 30 cast iron, rated 175 psi working pressure, with gauge ports at nozzles, and with vent and drain ports.

C. Impeller shall be non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut. Alternately a stainless-steel impeller may be used. 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.

D. Impeller shall be non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut. Alternately a stainless-steel impeller may be used. 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.

E. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and carbon seal ring, suitable for continuous operation at 225°F A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.

F. Pump bearing bracket shall have oil lubricated bronze journal and thrust bearings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibration shall be employed.

G. Motor shall meet NEMA specifications and shall be the size, voltage, and enclosure called for on Plans.

H. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

I. Approved pump manufacturers:

1. Xylem: Bell & Gossett
2. Armstrong
3. PACO
4. 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 ensure free rotation of the pump and motor.

E. Ensure system is free of foreign matter which could damage pump.

F. Coordinate with Specification 23 05 48 for inertia bases for each pump.

G. 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.

H. 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.

I. Check levelling and alignment and correct, if necessary, with shims under pump or motor feet.

J. 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.

K. Connect gauge cocks and gauges to gauge tappings.

L. Connect a gauge cock to the volute air vent connection.

M. Pipe a drain to the drip pan and volute drain and route to the nearest floor drain.

N. Connect power supply and control wiring to disconnect and motor controller.

O. After each unit has been run under actual operating conditions, shut it down and again check its alignment and adjust as necessary.

P. Follow all manufacturer recommended installation instructions to include following and completion of all recommended Pre-start and Post-Start checklists.

3.2 IN-LINE PUMPS

A. Suspend or support in-line pumps from structure as required, independent of the piping with pump installed level and motor upright (vertical).

B. Follow manufacturer’s installation and start-up instructions to ensure that the warranty is not voided.

C. Connect piping and support piping independently of the pump. It is imperative that piping be installed in such manner as not to impose any strain on the pump casing.

D. Connect gauge cocks and gauges to gauge tappings.

E. Connect a gauge cock to the volute air vent connection.

F. Pipe a drain to the drip pan and volute drain and route to the nearest floor drain.

G. Connect power supply and control wiring to disconnect and motor controller.

H. After each unit has been run under actual operating conditions, shut it down and again check its alignment and adjust as necessary.

END OF SECTION

SECTION 23 25 13

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, compression 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 of 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 one of the following:

1. Worth Hydrochem
2. Chemsearch
3. Garratt Callahan.
4. Nalco.
5. Betz.

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, HVAC 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°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 COMPRESSION TANKS

A. Compression Tanks for chilled and heating water piping systems shall be of the size and type as indicated on the Drawings.

B. Tanks shall be made of carbon steel with an ASME Boiler and Pressure Vessel Code Section V111, Division 1 stamp, rated for a minimum 240°F design temperature and 125 PSIG design pressure.

C. Each tank shall be primed and painted.

D. Provide each tank with a site glass, angle valves, mounting saddles, drain tapping, drain air charger valve assembly, Airtrol tapping and tank air control fittings.

E. Acceptable Manufacturers shall be:

1. Bell and Gossett Type ATF.
2. TACO.
3. AMTROL.

2.4 BUFFER TANKS, VERTICAL CHILLED WATER TYPE

A. Vertical chilled water buffer tanks shall be furnished in the sizes, gallons of storage capacity and approximate diameter, and locations where shown on the Drawings.

B. Each tank shall be manufactured of minimum 1/4" thick plate steel with 1/4" thick ASME Code 80:10 heads. The shell and heads shall be constructed from SA-516, Gr 70, steel. All pipe couplings and flanges shall be made from SA-105 steel. Each manway shall be made from SA-106C steel.

C. Tanks shall be supported on a minimum six inch (6") high steel skirt welded to the bottom of the tank.

D. The tank inlet and outlet nozzles shall have Type RFSO 150# Series flanges in the sizes to match the pipe sizes shown on the Drawings. Each nozzle shall be centered on opposite sides of the tank near the top or bottom of the shell (as low or as high as possible, refer to drawing arrangement shown).

E. Each tank shall have a Pressure Relief tapping centered at the top of the tank, minimum 3/4" in size, and shall be a Type FC, Series 3000#, coupling.

F. Each tank shall have two (2) drains, one (1) on each side of the internal baffle, with each drain being a minimum 1- 1/ 2" in size, located approximately centered on each side of the baffle at the low point of each half side. Tank drains shall be a Type HC, Series 3000#, coupling, each made of Type 304L stainless steel.

G. Each tank shall include a minimum of one (1) manway for access to the inside of the tank. Provide two (2) Manways where an internal coating is indicated to allow for proper application of protective coating specified. Each manway shall be made from minimum 3/4" thick steel, be 12" x 16" (oval) in size and be rated for 300 pounds.

H. All tanks shall be constructed to meet ASME Section VIII, Division 1, requirements and be rated at 125 PSI at 300 Deg. F. Each tank shall be hydrostatically pressure tested to no less than 160 PSI. Each tank shall bear the ASME stamp/label. Tanks shall not require radiograph testing.

I. All tanks shall be provided with two (2) lifting lugs for use in shipping and installation of each tank.

J. Tanks shall be coated on the outside with a red primer suitable for painting. The inside of all tanks (all steel surfaces) shall receive a two part enamel epoxy coating. In lieu of providing this coating provide a bottom shell, and the bottom 12" of the baffle connecting to the shell, both to be made from Type 304L stainless steel.

K. Each tank shall include a minimum 3/16" thick steel internal baffle plate that extends to the top or bottom of the tank and which extends to very near the bottom or top of shell (Refer to nozzle locations on drawings, within 6”-12"). The baffle plate shall be perpendicular to the nozzles. The plate design shall force water to flow through the entire tank without short circuiting.

L. Completely factory insulate the exterior of each steel tank, to include the shell, heads, manway, couplings, and nozzles with minimum two inch (2") thick heavy density fiberglass insulation board, cut and contoured to the shape of the tank. Fully jacket insulation with either a minimum 14-gauge metal jacket finished with a primer coating or use a 0.016-inch-thick aluminum jacketing neatly cut and contoured to the shape of the tank. Seal all insulation and jacketing seams and joints to be water and vapor proof. Loose fibrous insulation is not acceptable. Make couplings and nozzles fully accessible for making field connections without damaging insulation and jacketing system.

M. Buffer tanks shall be as manufactured by:

1. Wendland Manufacturing Corporation,
2. The John Wood Company,
3. Lochinvar,
4. American Wheatley,
5. RECO.

6. Or approved equals only.

2.5 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. Each Air Separator shall include a threaded NPT air removal connection on top of the unit so an air vent or expansion/compression tank can be connected, allowing collected air to be removed from the unit; minimum size of one inch (1”).

D. Provide a NPT blow down connection at the base of each separator to facilitate blow down of debris and sediment from within the separator on a regular basis; 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 a maximum of 350 Deg. F., design temperature, in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code. The manufacturer shall be registered with the National Board of Boiler and Pressure Vessel Inspectors.

G. Each Air Separator body shall be three (3) times the nominal inlet/outlet pipe diameter.

H. 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.

I. Acceptable Manufacturers shall be:

1. Bell & Gossett Rolairtrol Model RL (No Strainer),
2. TACO,
3. The John Wood Company, or
4. American Wheatley.

2.6 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.

2.7 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°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 125 PSIG.

2.8 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°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. or Neptune.

2.9 AIR VENTS

A. Refer to Section 23 21 13, HVAC Piping.

B. All air vent purging systems shall be furnished and installed by the piping system installer.

2.10 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 ensure 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 anywhere else indicated on the Drawings.

E. All piping specialties specified herein shall be installed in accordance with the manufacturer's recommended installation instructions.

3.2 FLUSHING, CLEANING, AND CHEMICAL TREATMENT

A. The chilled and heating water systems, existing and new, 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 ensure 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.

3.3 COMPRESSION TANKS

A. Support horizontal compression tanks from the overhead structure using Unistrut, Fahmet channels (back-to-back channels welded to tubing), or steel angles suitable for the expected component weights. These supports shall span not less than three (3) joists and rest on the bottom chord of steel joists using adequately sized support rods with double nuts. Tanks shall rest on sections of Unistrut, Fahmet channel or angles on specified saddles.

END OF SECTION

SECTION 23 31 00

HVAC DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 01 - 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; 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.

D. Test all low-pressure ductwork where run lengths exceed 60 ft and/or ductwork rises through two slabs or more in a concealed space. Pressure test shall be witnessed by test and balance contractor.

E. Pressure test grease exhaust duct systems and chemical exhaust duct systems.

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°F dry bulb, 50% RH, 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:

1. Submit manufacturer's descriptive literature and installation instructions in all items specified herein in accordance with Section 23 05 00.
2. Product data shall include product information 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.
3. Product data shall be submitted prior to submission or preparation of any shop drawings.

B. Shop Drawings:

1. Submit shop drawings in accordance with Section 23 05 00. Include items from this section in the shop drawings to properly depict location, type, volumetric air flow rate, and coordination with other trades.
2. Shop Drawings shall be submitted on all items of sheet metal work specified herein.
3. 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.
4. 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.

5. 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 Division 01.
6. 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.
7. 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.

C. Should any ductwork installation commence without approved product data or 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 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.

B. Products and material shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

C. Material not properly protected and stored, which has been damaged or defaced, or which has gotten wet during storage or construction shall be rejected.

D. All openings in the ductwork shall be covered with minimum three (3) MIL thick plastic during construction. All open ends shall be covered in plastic at the end of each construction day. Whenever the system is operated with the ducts open the open ends must be covered with a pleated media fabric fastened to the open end (use MERV-4 (min.) for these filters and only remove the filters to make final tie-ins).

E. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 GENERAL

A. All ductwork shown on the Drawings, specified, or required for the heating, ventilating, and air conditioning systems, shall be constructed and installed in a first-class workmanlike manner by trained and skilled sheet metal workers.

B. All ducts shall be installed 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.

C. 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.

D. 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).

E. Ductwork shall be classified, for construction standards, as follows:

1. Medium pressure from variable air volume supply fan (AHU) discharge up to the variable air volume terminal unit. This ductwork shall be constructed to withstand up to six inch (6") W.G. standards.
2. 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.
3. All exhaust air 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.
4. 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.

F. Duct Construction Materials

1. Except as noted otherwise, ducts, plenums, and casings shall be constructed of new lock forming quality galvanized prime grade steel sheets.
2. 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".
3. For special system types, refer elsewhere for construction materials requirements.

G. Plenum Chambers

1. Plenum chambers shall be constructed of 18-gauge sheets thoroughly braced with 1-1/2 inch angle irons.
2. All duct panels in rectangular galvanized steel ducts which are 12 inches and wider and which are not lined shall be cross broken.

H. Elbow Duct Fittings

1. Make square elbows where shown or required, with factory fabricated double thickness turning vanes.
2. Job fabricated vanes will not be acceptable.
3. Vanes shall be a manufactured product as specified elsewhere in this specification.
4. 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.
5. Elbows with a radiused outside corner and a mitered inside corner are not acceptable means of transitions and shall not be installed.

I. Duct Transitions

1. Make transformations in duct shape or dimension with gradual slopes on all sides.
2. 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.

3. 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.
4. Where a transition must be made with less slope than that noted above, install single thickness guide vanes to ensure 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.

J. Duct Routing

1. Ducts shall be routed in conjunction with all types of pipes, electrical conduits, ceiling hangers, etc., so as to avoid interferences insofar as possible.
2. Duct Penetrations

    a. 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.
    b. When the Contractor believes such penetrations are unavoidable, notify the Owner's Representative for approval prior to commencing with such work.
    c. Otherwise, all such penetrations are not expected to occur and are not allowed.
    d. Such penetrations will not be allowed for the convenience of, or lack of coordination by, the Contractor.
    e. 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.

3. Duct Routing Through Walls

    a. 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.
    b. 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.

K. 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 ensure outlets and grilles will be accurately trued up with ceiling.

L. Ductwork shall be fabricated in a manner to prevent the seam or joints being cut for the installation of grilles or diffusers.

M. Duct Supports

1. All sheet metal ductwork shall be securely hung from the building construction.
2. 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.
3. 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.

N. Holes and Openings in Ductwork

1. 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.
2. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.
3. All panels of uninsulated ducts twelve inches (12") and larger shall be cross broken.
4. 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.

O. Manual Air Balancing Dampers

1. 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.
2. Splitter Dampers
    a. 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.
    b. No splitter dampers shall be installed in medium pressure ductwork, unless specifically shown on Drawings.
    c. 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.
    d. Dampers shall have brass, bronze, or approved plastic bearings.
    e. 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").
    f. Where splitter dampers exceed 12 inches in height two (2) pull rods shall be used.
    g. Splitter dampers 12 inches (12") in height or less shall have one (1) pull rod.
3. Butterfly Dampers
    a. Butterfly damper blades in round ducts shall be the full width of the duct in which they are installed.
    b. Dampers shall be constructed of a minimum 22-gauge metal.
    c. 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.
4. Operating Rods
    a. 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.
    b. Operators shall be attached to duct where regulators occur above a lay-in ceiling.
    c. Use a Ventlock No. 555 locking quadrant on accessible concealed splitter dampers.
    d. 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.
    e. Where dampers occur above or behind plaster or other inaccessible ceilings, walls, chases or furrings, the regulator shall be an Electronic Balancing Damper as specified elsewhere.
    f. Young Regulator bearings shall also be provided on the opposite end of each operating rod.
5. Rectangular Opposed Blade Volume Dampers
    a. Rectangular opposed blade volume dampers shall be as manufactured by
        1) AWV (American Warming and Ventilating),
        2) Pottorff,
        3) ABI (Air Balance Inc.),
        4) Greenheck, or
        5) Ruskin.
    b. Blades shall not exceed 48 inches in length or twelve inches (12") in width, and shall be the opposed interlocking blade type.
    c. The blades shall be of not less than No. 16 gauge steel supported on one-half inch (1/2”) diameter rustproofed axles.
    d. Axle bearings shall be the self-lubricating ferrule type.
6. Inaccessible Manual Balancing Dampers / Remote Balancing Dampers and Operators
    a. Where dampers occur above or behind plaster or other inaccessible ceilings, walls, chases or furrings, provide a remotely operated manual balancing damper system to allow proper air balance by the test and balance contractor.

b. Reference the architectural drawings for locations of gypsum, spline ceilings and other inaccessible locations.
c. Some (not all) critical areas requiring remote dampers have notes on drawings.
d. Damper regulator shall be a universal worm gear drive actuated by an unsheathed rotary cable which is captured at the damper end by a shaft coupling integral to the worm gear assembly. The rotary cable shall be terminated at the ceiling or in a wall opening or otherwise noted concealed location inside a backbox / cup that is securely mounted to the wall or ceiling or other location noted (location to be strictly coordinated with Architect).
e. The drive shall be a complete assembly with universal mounting capabilities to accommodate damper shaft sizes from ¼" to 3/8" square or ¼" to ½" round.

1) 14-gage galvanized mounting bracket
2) Aluminum worm and gear
3) Black oxide coated steel drive shaft/cable coupling

f. Provide cable support clamps.
g. Provide backbox / cup cover plates to match surface finish in coordination with Architect.
h. Acceptable Manufacturers:

1) Metropolitan Air Technology (MAT)
2) Young Regulator Company

i. In lieu of the manual remote control cable system the Contractor may provide an electronically operated remote control balance damper powered by a hand-held controller using battery power to stroke the low voltage damper motor located at the balance damper. See specifications for electronic remote balancing dampers in Section 23 33 00 – Air Duct Accessories.

P. 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 where branch ducts meet trunk ducts, they shall be equal to Titus AG-45 with operator adjustable from the duct exterior.

2.2 MEDIUM PRESSURE DUCTWORK:

A. Construction

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"

2. Additional reinforcing shall be per current SMACNA Requirements.

B. Rectangular Ductwork

1. 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".
2. Gauge thickness of the ductwork shall meet that as scheduled above.

3. Reinforcing methods 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.

C. Round Ductwork

1. 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".
2. Straight ducts and fittings shall be of the same manufacturer.
3. Spiral wound ducts shall be used up to 48" in diameter.
4. Approved Manufacturers:
    a. United Sheet Metal Company
    b. Other approved equals.
5. Joints shall be joined by approved couplings secured by sheet metal screws and sealant.
6. Ninety-degree branch take-offs shall be made with conical tees.
7. Take-off fittings shall be welded to fittings or to the main duct. All welds shall be cleaned and coated with rust-inhibiting paint.
8. 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.
9. Ducts shall be constructed with four-ply reinforcing spiral lock seams.
10. Approved fittings manufacturers:
    a. United Sheet Metal Company
    b. Ward
    c. Other approved equals only

D. Flat Oval Ductwork

1. Flat oval medium pressure ducts, if used, shall be spiral flat oval or welded flat oval.
2. Approved Manufacturers:
    a. United Sheet Metal Company
3. Ductwork shall be constructed of gauges and reinforcing as recommended by the manufacturer for medium pressure duty.
4. 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

5. Approved fittings manufacturers:
    a. United Sheet Metal Company
    b. Ward
    c. Other approved equals only
6. See elsewhere herein for requirements related to sealing, etc..
7. Fittings shall be matching type manufactured with continuous welds.

E. Sealant

1. Sealant 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 round or oval joints.
   b. Externally seal all longitudinal and transverse duct joints after these joints are closed.
   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 requirements. Use double sealant at corners of these joints.
2. All sealants shall be U.L. listed and labeled in accordance with U.L. 181 for duct sealant.
3. Acceptable Products:
   a. MMM EC-800
   b. Hardcast "Iron-Grip 601"
   c. Childers CP-146
   d. Foster 32-18
   e. Polymer Adhesive Sealant Systems, Inc. "Air Seal No. 11"

F. Medium pressure duct supports:

1. 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

2. 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

3. 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.
4. Hanger straps on ducts with widths over 60 inches shall be bolted to duct reinforcing with 3/8" bolts minimum.
5. Use 3/8" minimum bolt for securing round duct hanger straps to band straps.

G. Where galvanized steel ductwork or joints are welded use “Everdur” welding rods.

2.3 LOW PRESSURE DUCTWORK:

A. Rectangular, low-pressure, 2” W.G.

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"

2. 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.
3. Tthe gauge thickness of the ductwork shall meet that as scheduled above.

B. Rectangular, low-pressure, 1” W.G.

1. Rectangular low-pressure ducts, for systems designated to be operating at up to one (1) inch 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"

2. 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.
3. The gauge thickness of the ductwork shall meet that as scheduled above.

C. Round, low-pressure

1. Round low-pressure ducts shall be spiral wound as manufactured by United Sheet Metal Company or have grooved seams with flat snaplock longitudinal seams.
2. Spiral seam round duct gauge thicknesses shall be that standard by the manufacturer for the pressure rating of the system.
3. 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

4. Elbows in round duct systems
    a. Elbows shall have a centerline radius of 1-1/2 times duct diameter or width.
    b. Elbows may be stamped (smooth) elbows, or segmented (5 piece 90 degree elbows and 3 piece 45 degree elbows). Elbows may not be adjustable type. Adjustable round duct elbows shall not be permitted in this project.
    c. Joints of round ducts shall be slip type with a minimum of three (3) sheet metal screws.
5. Branch Connections
    a. Branch connections to round ductwork shall be as shown and noted on the drawings.
    b. Tees and taps are both permitted but shall be either conical, lateral, or have a lead in. Straight connections are by approval only.

D. Sealant

1. All low-pressure ductwork shall be externally sealed using water-based products.
2. Acceptable sealant products include the following.
    a. United McGill Corporation United Duct Sealer,
    b. Hardcast "Iron-Grip 601"
    c. Childers CP-146
    d. Foster 32-18
    e. Polymer Adhesive Sealant Systems, Inc. "Air Seal No. 11"
3. Duct sealer shall be installed on the joints after closure.
4. All sealants shall be U.L. rated for the application.
5. 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.).
6. Do not seal control rods for actuated dampers and fasteners.
7. Each system shall meet a seal class of “A”.

E. Low-Pressure Duct Supports:

1. 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.
2. Duct shall have at least one pair of supports 8'-0" on centers.
3. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.
4. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers.
5. 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"

6. 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.
7. For special support requirements see details on the drawings.
8. Where the anchor for duct supports exceeds 4'-0" additional support bracing shall be provided to keep the vertical length of support straps or rods to a maximum 4'-0".
9. 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.
10. Reinforcement spacing shall be reduced as required to meet the construction standard specified using the gauge thickness scheduled.

2.4 ROUND LOW-PRESSURE DUCT TAPS TO RECTANGULAR DUCTWORK

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.

C. Spin-in fittings shall be conical type as noted 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.

D. 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.

E. Provide plain or beaded ends for connection of duct work as required for the application. Crimped ends are not allowed.

F. 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.

G. All spin-in, conical 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.

H. Acceptable Manufacturers:

1. Flexmaster or equals by,
2. Crown Company Products,
3. Ductmate,
4. Hercules Industries.

2.5 ROUND FLEXIBLE INSULATED DUCTWORK:

A. All round, flexible, insulated ducts, low- and high-pressure type, shall be factory fabricated and insulated.

B. Acceptable Manufacturers equal to:

1. Flexible Technologies / Thermaflex M-KE
2. Flexmaster Type 3M.

C. Flexible duct thermal conductance shall be based on a 75°F mean temperature. 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.

D. 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.

E. 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.

F. Flexible ducts shall be suitable for operating temperatures of -20 up to 250°F.

G. 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.

H. Maximum vapor transmission rating shall be 0.05 Perms as rated in accordance with ASTM-E-96.

I. Unless otherwise noted, the maximum length of flexible duct shall be limited to five feet (5').

J. Securement

1. 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.
2. Fold insulated outer vapor barrier jacket liner over the first band and secure with a second plenum rated panduit band.
3. Make connection vaportight 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.
4. Coating must adhere to MIL-PRF-19565C with a permeance rating of less than 0.02 perms per ASTM-E-96, procedure B.
5. No cloth backed duct tape is allowed.
6. All fasteners, adhesives, and duct tape used shall be U.L.rated for the application.
7. All duct tapes used shall be acrylic based.

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
2. Approved equal to the above

2.7 DUCT LINER

A. Refer to Section 23 07 00 - HVAC Insulation, for further related requirements.

B. Where indicated on the Drawings or specified herein, all rectangular transfer, all return duct within 10' of the fans; shall be lined with Fiberglass mat faced duct liner in the thicknesses, type, and locations as indicated elsewhere herein.

C. Kitchen grease hood exhaust, kitchen dishwasher exhaust, kitchen hood make-up air, dryer exhaust, fume hood exhaust, boiler flues, and other industrial type exhaust air ducts shall not be lined. Line all other general building exhaust air ducts within 10'-0" on each side of each in-line exhaust fan with one inch (1") thick liner. Roof mounted exhaust fan ductwork shall also be lined, one inch (1") thickness, but only for the first 10'-0" of ductwork from the roof curb toward the occupied space.

D. All transfer air ducts shall be lined with one inch (1") thick duct liner.

E. The liner insulation system shall 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.

F. All ductwork systems are required to meet the most recent version of the International Energy Conservation Code or the energy code governing the project.

G. 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°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°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.

H. 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”.

I. 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. Leading edges of liner shall additionally receive a metal nosing.

J. 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.

K. 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".

L. 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.

M. Where rectangular ducts are lined and adjoins externally insulated rectangular ducts, the two insulations shall be overlapped not less than twenty-four inches (12").

N. 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.

O. All exposed ductwork shall be internally lined unless specifically indicated otherwise.

P. Acceptable liner manufacturers 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 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.

2.9 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° and 90°) 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 6.0 at 75°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.

E. Exposed lined spiral seam ductwork shall have a paint grip finish suitable for painting.

2.10 KITCHEN HOOD GREASE 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.

2.11 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.

2.12 CHEMICAL EXHAUST DUCT SYSTEM

A. Chemical storage exhaust ductwork shall be constructed of Type 316 stainless steel. This shall include ductwork from the exhaust collar to the discharge point to the outdoors.

B. Exposed duct, shall be 20-gauge (minimum 0.0335 inches thick) in thickness. Concealed ductwork shall be 22-gauge in thickness (minimum 0.0273 inches thick).

C. All joints shall be fully welded and heat treated. Alternately, prefabricated round stainless-steel duct systems, with approved air tight connections, will be considered where they fit the available space to include using all radius bends.

D. Slope duct 1/4 inches per foot from discharge point back to hood.

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 and vented to the exterior through weather-protected openings.

F. Make rigid connections to the fan, transitioning from duct size indicated on Drawings to full size of fan/curb connection, as required, for connection at each piece of equipment. Seal duct connections to each fan.

G. Do not internally line chemical exhaust ductwork.

2.13 DRYER VENT EXHAUST DUCT SYSTEM

A. Dryer vent exhaust duct work shall be constructed of minimum 26-gauge galvanized steel or aluminum sheet metal. Sheet metal gauge shall be increased in size to correspond to table previously provided for low pressure round ductwork.

B. All duct work shall have a smooth interior finish and have interlocking fittings so that they do not require screw fasteners. No screw fasteners shall be used that puncture duct work. Support duct work at minimum four-foot (4') intervals. All transitions shall be made outside of the duct wall. Refer to the International Mechanical Code (IMC) for additional requirements.

C. For all dryer vent exhaust ducts concealed in building construction (i.e., in walls or above inaccessible ceilings), provide a permanent identification label or tag located within six feet (6') of the dryer connection, that lists the total equivalent length of the exhaust duct as defined by the IMC or the Manufacturer (Where longer than 35 equivalent feet note the allowed length of the dryer manufacturer). Label to be mounted to wall near exhaust duct and comply with equipment tag label requirements in Section 23 05 53.

D. Provide termination caps or hoods with a backdraft damper but without screens. Refer to Drawings for details of terminations.

2.14 FIBERGLASS DUCTBOARD

A. Fiberglass ductboard of any type is not allowed on this project without exception.

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 duct mounted components such as heating coils, electric or water type, sound attenuators, air terminals, etc. in accordance with the manufacturers' recommendations.

D. 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, and before all fans and air conditioning units are operated, all debris and foreign matter shall be removed from the air systems.

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. Ensure 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 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 medium pressure rated system (3.0 Inches W.G. or higher) shall not exceed 2% of the design operating air volume; or, whichever is most restrictive, be equal to a rate of air leakage (CL) of 4.0, or less, in accordance with the following equation (from International Energy Conservation Code, 2021):

1. Leakage Rate 4.0 (or less) = F/P0.65
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, where the supply, return or exhaust ductwork exceeding 65 feet in total continuous linear feet, vertical ductwork routed concealed through two or more levels, chemical exhaust ductwork, and all grease 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 equal to duct construction pressure rating (i.e., 2” w.g. for 2” w.g. construction and 1” w.g. for 1” w.g. construction), 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 or less than the rate of leakage allowed by the energy code governing the project.

I. Provide duct leakage test report summary for submission and review by the Owner's Representative. Tests 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 previously herein.

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 2021 International Mechanical Code (IMC).

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

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 accessories 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; air volume control devices; hangers and supports; plenums and casings; 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.

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. 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.

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.

1. Product data shall include product information with individually assembled cut sheets, and details of all duct accessories proposed.
2. Product data shall be submitted prior to submission or preparation of any shop drawings.

B. Shop Drawings: Submit shop drawings in accordance with Section 23 05 00. Include items from this section in the shop drawings to properly depict their location, type, volumetric air flow rate, and coordination with other trades.

1. 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.
2. 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.
3. 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 Division 01.
4. 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.
5. 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.

C. Should any ductwork installation commence without approved product data or 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 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.

B. Products and material shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

C. Material not properly protected and stored, which has been damaged or defaced, or which has gotten wet during storage or construction shall be rejected.

D. All openings in the ductwork shall be covered with minimum three (3) MIL thick plastic during construction. All open ends shall be covered in plastic at the end of each construction day. Whenever the system is operated with the ducts open the open ends must be covered with a pleated media fabric fastened to the open end (use MERV-4 (min.) for these filters and only remove the filters to make final tie-ins).

E. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 ELECTRONIC BALANCING DAMPERS

A. Where balance dampers are to be located above a hard ceiling, or in any inaccessible location (see Architectural ceiling plans), 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 an LCD meter.

B. Each Remote Damper Assembly shall consist of a commercial quality damper actuated by a 12Vdc 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 12Vdc 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 lbs-in (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 ensure 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. Strictly coordinate ceiling and wall locations and finish options for the connections with the Architect.

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 12Vdc 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. Metropolitan Air Technology (MAT).
2. Young Regulator.
3. Greenheck.
4. Or other approved equals.

2.2 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 09 00, 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.

2.3 BACKDRAFT DAMPERS

A. General

1. Provide counterbalanced backdraft damper where shown on drawings and not integral to equipment or provided as an equipment accessory.
2. Counterbalance backdraft damper shall be capable of the following configurations as the application requires.
    a. Horizontal mount with air flowing down
    b. Horizontal mount with air flowing up
    c. Vertical mount with air flowing horizontally
3. Dampers shall be tested in accordance with AMCA Standard 500-D.

B. Construction

1. Extruded aluminum channel frame
2. Extruded aluminum blades, parallel
3. Counterbalance bar adjustable for final setting in the field
4. Corrosion-resistant, long-life, synthetic bearings
5. Blade seals on blade edge
6. Corrosion-resistant, long-life, synthetic axles

C. Performance

1. Temperature: -40°F to 200°F
2. Capacity
    a. Closed: maximum back pressure of 16 in. w.g. for 12” wide damper
    b. Open: maximum air velocity of 2,500 fpm
3. Blade Operation
    a. Start to Open: 0.01 in. w.g.
    b. Fully Open: 0.07 in. w.g.
4. Pressure Drop: maximum 0.15 in. w.g. at 1,500 fpm through 24”x24” damper

D. Accessories

1. Provide accessories as required for a full and complete installation and successful operation.
2. This includes any necessary frames or sleeves.
3. This includes any necessary duct transition connections for round, oval, or rectangular profiles.

E. Manufacturers | Models

1. Ruskin | CBD6
2. Or equals by
    a. Greenheck
    b. Pottorff | CBD-250
    c. Mestek, AWV (American Warming and Ventilating)
    d. ABI (Air Balance Inc.).

2.4 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 6.0. 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, gypboard 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.

J. Approved manufacturers and products:

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.

2.5 FLEXIBLE CONNECTIONS

A. At the inlet and/or discharge of air distribution equipment (unless otherwise noted), furnish and install vibration isolators of the flexible duct connection type.

B. The flexible duct connection vibration isolators provided shall be rated for the application in which they are installed.

C. The flexible duct connection vibration isolators shall be a coated woven fabric.

D. 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 (width of connector shall adjust accordingly).

E. Normal, conventional HVAC applications

1. Temperature Rating (continuous use): 200°F
2. Grade Weight: 30 oz./yd²
3. Features:
    a. Fire-resistant (NFPA 701 compliant for Flame Spread & Smoke Development)
    b. Waterproof
    c. Mildew-resistant
    d. Air leakage resistant

F. Exterior, sun/weather exposure applications

1. Temperature Rating (continuous use): 0°F - 275°F
2. Grade Weight: 26 oz./yd²
3. Features:
    a. Fire-resistant (NFPA 701 compliant for Flame Spread & Smoke Development)
    b. Waterproof
    c. Mildew-resistant
    d. Air leakage resistant
    e. Resistant to sunlight, ozone, and weather

G. High temperature applications

1. Temperature Rating (continuous use): 30°F - 500°F
2. Grade Weight: 16 oz./yd²
3. Features:
    a. Fire-resistant (NFPA 701 compliant for Flame Spread & Smoke Development)
    b. Waterproof
    c. Mildew-resistant
    d. Air leakage resistant
    e. Resistant to withstand high temperatures continuously (1,000 hours at 500°F)

H. Corrosive environmental applications

1. Temperature Rating (continuous use): 30°F - 180°F
2. Grade Weight: 14 oz./yd²

3. Features:

   a. Fire-resistant (NFPA 701 compliant for Flame Spread & Smoke Development)
   b. Waterproof
   c. Mildew-resistant
   d. Air leakage resistant
   e. Resistant to corrosive environments

I. Acceptable Manufacturers:

1. Vent Fabrics "Ventglas"
2. Duro-Dyne

2.6 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 Terminal Units
2. Indoor Air Handling Units
3. D/X Air Handling Units.
4. Packaged Rooftop A/C Units.
5. Heating and Ventilating Units.
6. Make-Up, or Supply, Air Units.
7. Filter Return Air Grilles serving ducted return air systems where scheduled.
8. 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. Medium efficiency air filters shall generally be 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 AHRI 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 ensure 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

5. Filters shall be suitable for operation with varying velocities of up to 500 feet per minute (FPM) for 2" filters and 350 FPM for 1" filters.
6. Filters shall have a minimum efficiency of 30% with an average arrestance of 90 to 92% minimum dust holding capacity which shall be no less than 170 grams as tested in accordance with ASHRAE Standard 52.1. Filters shall also have a MERV rating as tested in accordance with ASHRAE Standard 52.2.

   a. Filters for ATUs shall be MERV-11.
   b. Filters for AHUs shall be MERV-11.

c. Filters for RTUs shall be MERV-11.
d. Filters for PTACs shall be MERV-11.

7. Acceptable Manufacturers:

a. Camfil Farr, Inc., Model Aeropleat, or approved equals by:
b. Environmental Filter Corporation.
c. Eco-Air.

C. All filters shall be standard sizes that are readily and locally available, in stock, through multiple over the counter sources without requiring special order.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all ductwork, duct accessories, 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 duct mounted components such as heating coils, electric or water type, sound attenuators, air terminals, etc. in accordance with the manufacturers' recommendations.

D. 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, and before all fans and air conditioning units are operated, all debris and foreign matter shall be removed from the air systems.

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. Ensure all duct openings are capped and sealed during construction when additions are not being made.

3.3 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.

3.4 FILTERS

A. No air moving equipment may be operated at any time without filters being fully installed in equipment.

B. The Mechanical Contractor shall provide a min. MERV-8 filter in equipment from the point the equipment is installed through start-up up to Test and Balance work occurs. These construction filters may need to be changed out during this period of time depending on the duration of time, frequency of run-time for the equipment, and the quality of air in the building. Replace filters during construction as directed by the Owner's Representative. Filters used prior to TAB work may be MERV-8 (min.).

C. Install one (1) new complete set of final filters, as directed by the Test and Balance (TAB) Firm, just prior to performance of TAB work.

D. Install one (1) new set of final filters at "Substantial Completion" of the project.

E. The Mechanical Contractor shall provide a final set of filters for equipment when Test and Balance work begins, then another set at project close-out. An additional set of final filters shall be furnished to the Owner for attic stock. Therefore, a minimum total of three (3) final sets of filters shall be provided for all air handling and fan coil units, as well as for filter return air grilles where scheduled.

F. Document, in writing, when each filter change-out occurs.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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 bear 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. Cardboard is not an acceptable covering or protective material from rain, snow, or other precipitation.

B. Products and materials shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

C. 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.

D. Storage and protection of materials shall be in accordance with sections in Division 23.

PART 2 - PRODUCTS

2.1 FANS - POWER ROOF VENTILATORS

A. Fans shall be direct or belt-drive, downblast or upblast 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 and automatic belt tensioners.

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 eighteen inches (18") 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 upblast grease exhaust models will not have backdraft dampers.

F. Provide grease container, hinged curb-base, for inspection and cleaning of duct, and 24" high vented curb on upblast grease hood exhaust fans.

G. For upblast dishwasher hood fans provide epoxy coating on all materials of construction exposed to the air stream.

H. For all chemical exhaust system fans provide epoxy coating on all materials of construction exposed to the air stream.

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. Provide automatic belt tensioners on all belt drive fans.

K. Acceptable manufacturers:

1. Loren Cook.
2. Greenheck.
3. ACME.
4. Penn.
5. FloAire.
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.

H. Curbs shall be minimum eighteen inches (18") 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.

I. Provide inlet grille to be approved by Architect.

J. Acceptable manufacturers and models:

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 IN-LINE 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:

1. Motor encased in housing out of air stream, factory-wired to disconnect located on outside of fan housing.
2. Storm shelter fans shall have electronically commutated, direct-drive motors with soft-start capabilities.

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. Provide automatic belt tensioners.

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.

2.4 DRYER EXHAUST POWER VENTILATORS

A. Dryer exhaust power ventilators shall be provided in the dryer exhaust air system for a dryer that is suitable for such a ventilator when the dryer is not able to perform properly due to excessive dryer exhaust duct lengths or restrictive configurations.

B. All dryer exhaust power ventilators provided shall be UL 705 listed for power ventilators.

C. Provide a secondary lint trap.

D. Provide manufacturer's kit including the following.

1. Fan
2. Tubing
3. Grommet for tubing
4. Labels
5. Clamps
6. Hardware and brackets
7. Indicator panel and cover plate
8. Communication cable
9. Warning label for indicator cover plate.
10. Pressure sensor switch
11. Controller as required for operation

E. Acceptable manufacturers or equal:

1. Fantech
2. LFSystems

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to the site as indicated in Division 01.

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 in coordination with roofing contractor and architectural requirements.

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

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SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Comply with Division 01 - 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 air inlets and outlets as shown on the Drawings, these being air diffusers, grilles and registers; FEMA ICC 500 storm rated louvers, gravity ventilators / hoods, 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 the air inlets and air outlets, coordinating device mounting / installation options, coordinating device finish options, and developing Shop Drawings illustrating such.

1.3 QUALITY ASSURANCE

A. All equipment, products, 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, ICC 500 Standard for the Design and Construction of Storm Shelters, and all other applicable National, State, and Local Codes or ordinances.

B. All equipment, products, and materials shall be installed in a workmanlike manner by trained and experienced technicians and mechanics as recommended by the manufacturers of the products installed.

C. 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.

D. Air quantities shown on the Drawings, or specified, are based on air at 75°F dry bulb, 50% relative humidity, and 29.92 inches H.G. barometric pressure.

E. 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.

1.4 SUBMITTALS

A. Product Data:

1. Submit manufacturer's descriptive literature and installation instructions for all items specified herein in accordance with Section 23 05 00.
2. Product data shall include product information with individually assembled cut sheets, and details of all air outlets and inlets and other accessories proposed to be used for the air movement in and out of HVAC systems and connection to those systems. This shall be done prior to submission or preparation of any shop drawings.

3. Product data shall include for the FEMA ICC 500 storm louvers, the manufacturer's mounting / installation instructions, indicating the specific applications in this project which shall be coordinated with the Architect, Structural Engineer, and General Contractor.

B. Shop Drawings:

1. Submit shop drawings in accordance with Section 23 05 00. Include items from this section in the shop drawings to properly depict their location, type, volumetric air flow rate, and coordination with other trades.
2. Shop Drawings submitted in accordance with Section 23 05 00, 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.
3. 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 Division 01.
4. 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.
5. 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.

C. Should any air outlet or inlet installation commence without approved product data or 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.

B. Products and material shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

C. Material not properly protected and stored, which has been damaged or defaced, or which has gotten wet during storage or construction shall be rejected.

D. All openings in the ductwork shall be covered with minimum three (3) MIL thick plastic during construction. All open ends shall be covered in plastic at the end of each construction day. Whenever the system is operated with the ducts open the open ends must be covered with a pleated media fabric

fastened to the open end (use MERV-4 (min.) for these filters and only remove the filters to make final tie-ins).

E. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 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 / 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).

F. 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.

G. Where called for on the schedule, grilles, registers, ceiling outlets, diffusers, and other air devices shall be provided with deflecting devices and manual dampers.

H. Where indicated on the Drawings, provide a fire rated blanket on the back side of steel ceiling mounted air devices (supply, return, exhaust, etc.).

I. Provide an insulation blanket on the back side (all surface area) of ceiling mounted supply air devices to prevent condensation.

J. Please provide the air inlet/outlet accessories noted in the Grilles, Registers, and Diffusers schedule on the drawings and in any notes on the drawings.

K. All air devices shall be the standard product of the manufacturer, subject to review by the Engineer and Architect.

L. Acceptable manufacturers are:

1. Titus, or approved equals only by:
2. Krueger.
3. Nailor.
4. Greenheck / Metal-Aire.
5. Carnes.
6. Price Industries.

2.2 FABRICATED ALUMINUM FEMA 361 (ICC STANDARD 500-2020) GRILLE (LOUVER/BAFFLE)

A. Furnish and install heavy duty fabricated aluminum grilles, louvers, or baffles, at all penetrations made through walls or roof of the International Code Council (ICC) Standard 500-2020, Standard for the Design and Construction of Storm Shelters in the sizes, locations and configurations as shown on the Drawings.

B. Aluminum Grilles, louvers or baffles shall be made of heavy duty welded aluminum blades having a chevron shape, or inverted “V” shaped blades, to prevent direct flying debris from directly entering the storm shelter penetrations or openings. All grilles shall be rated to comply with the requirements of Federal Emergency Management Agency (FEMA) 320 or 361 testing requirements (for protection from high wind loads and air borne debris or projectiles).

C. Aluminum grilles may be installed in the wall or roof on the outside portion of any penetration as a stand-alone device, in front of standard wall louvers or in front of an internal shutter or door of standard construction to close off the opening when not in use for the transfer of air (forced air circulation) or for natural ventilation air purposes. The grilles shall be rated for a minimum wind load of 248 Pounds per Square Foot (PSF), 250 Miles Per Hour (MPH), and be able to withstand a 15-pound wooden 2” by 4” traveling at a minimum of 100 MPH.

D. Grilles shall provide for a high free area and very low air pressure drop or airflow resistance.

E. Provide the minimum free area, in square feet, for each size grille, as designated on the drawings. Submit individual data for each grille to include individual sizes, air flow rates, air pressure drops (to include accounting for interior debris screens), frame types, color and finish selection options, cut sheet data of dimensions and weights for each size to be used, installation instructions and any other data as requested by the structural engineer as needed to verify acceptable performance and suitability for actual mounting conditions encountered.

F. All grilles shall be Underwriters Laboratories (UL) listed as a wind storm rated assembly.

G. Louver shall be AMCA certified for water penetration air performance. The basis of design product performance for water penetration is 1250 FPM for the beginning of water penetration.

H. Provide mounting frames for all grilles of a flush in wall, recessed in opening, with an eight inch (8”) deep frame made of ¼” thick aluminum with framed flanges on two opposite ends. The inverted “V” blades shall also be made of minimum 3” by 3” by ¼” thick aluminum which shall be fully welded, and then welded into the frame. Cantilever style frames not allowed unless specifically detailed not to be flush in the wall or roof penetration.

I. Provide a stainless steel ½” by ½” size mesh, using 18 Gauge wire, debris screen to be mounted on the inside shelter side of the grille. Alternately a flattened aluminum bird screen is acceptable.

J. Provide a flush, recessed mount grille frame (flush with the outside finished wall surface).

K. All grilles shall be made from aluminum unless otherwise noted. Where steel components may be allowed, only where designated, these shall be powder coat painted in an Owner/Architect selected color from a manufacturer furnished color palette, minimum 20 unique colors to be available for selection. Factory finishes shall be warranted for a minimum of one (1) year from the date the grilles are placed into beneficial use of the Owner, generally coinciding with Substantial Completion. Aluminum grilles shall have an aluminum mill finish.

L. Provide removable aluminum or steel (only where designated) lifting lugs which shall be removed at the completion of installation. Touch up any paint finishes should such be marred during installation, as applicable.

M. All grilles shall be installed in accordance with the grille manufacturers recommended installation instructions. Perimeter of grilles to be sealed with a non-hardening flexible outdoor rated sealant. Use stainless steel rods or bolts with anchors and epoxy (rods) or plate washers or tap and nut (metal structures) in the sizes, penetration depth and spacing as per the pertinent FEMA rating of the grille.

N. Refer to Structural Engineering and Architectural Drawings for all mounting conditions and details to include identification of the structural wall or roof material being penetrated.

O. Storm rated grilles shall be as manufactured by:

1. Pottorff, Model XCD-545.
2. Equal by Ruskin.
3. Equal by Greenheck.
4. Equal by United Enertech.

2.3 OUTSIDE AIR INTAKES AND RELIEF/EXHAUST AIR OUTLETS / GRAVITY VENTILATORS / 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 1,000 FPM for outlets and 500 FPM for intakes. Air pressure drop shall not exceed 0.10 In. w.c. 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 18-inch-high roof curbs for outlets and intakes. Curbs shall be constructed 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. Loren Cook, or approved equals by:
2. Greenheck.
3. Penn "Airette"
4. Acme.

PART 3 - EXECUTION

3.1 COORDINATION

A. Approved product data shall be shared with other trades as required for an integrated building construction.

B. Storm louver product data, including manufacturer’s installation guides and selected product dimensions shall be shared with the General Contractor, Structural Engineer, and the installer of the storm shelter wall.

3.2 INSTALLATION

A. Install all air inlets and outlets as indicated on the Drawings in full accordance with these specifications including brackets, foundations, hangers, supports, etc.

B. Seal connections to all ductwork as specified, pressure test, and repair leaks.

C. Install all air intake, relief and exhaust air gravity ventilators/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 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.

F. Installation of FEMA ICC 500 storm louvers shall be strictly coordinated with the installation of the storm shelter envelope (walls and roofs). The storm louver's manufacturer installation recommendations and the dimensions of the selected louvers shall be provided to the Construction Team for coordination and review by the Architect and Structural Engineer.

3.3 CLEANING

A. Before the grilles or diffusers are installed, and before all fans and air conditioning units are operated, all debris and foreign matter shall be removed from the air systems.

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. Ensure all duct openings are capped and sealed during construction when additions are not being made.

D. Clean grilles, registers, and diffusers subsequent to installation, prior to substantial completion. Damaged devices shall be repaired or replaced appropriate to the damage incurred.

END OF SECTION

SECTION 23 51 23

GAS VENTS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with General Requirements in Division 01, 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 under this section of specifications shall include the furnishing and installation of Breeching, Vents (stacks), Chimneys, and Generator Set Exhaust systems as specified herein for all fuel fired equipment installed under Division 23 and 26 (Generators).

B. Contractor shall connect all flue/combustion vents, all factory furnished and field installed accessories, plates, shields, appurtenances, insulation, hangers, supports, etc., for all fuel fired appliances installed under Division 23 and 26 (Generators).

C. This section includes the following:

1. Type B vents.
2. Listed duct work for condensing appliances.
3. Listed building-heating appliance/factory built chimneys.

D. Gas Appliance Categories are defined as follows:

1. Category I - An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
2. Category II - An appliance that operates with a non-positive static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.
3. Category III - An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
4. Category IV - An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

1.3 SUBMITTALS

A. Product Data: Submit complete manufacturer’s descriptive installation instructions for the configuration of flue vents/stacks/chimneys proposed to include:

1. Flue vent arrangements.
2. Flue vent sizes, dimensions, and weights.
3. Installation methods to include accessories.
4. Flue vent sizing calculations based on equipment actually submitted to be used on project.

B. Shop Drawings

1. Submit in accordance with Section 23 05 00.
2. Submit Shop Drawings for breechings, vents, chimneys, and generator set exhausts. Include plans, elevations, sections, details, and attachments to other work.

C. Submit copies of any special warranties required in this section of specifications.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Certified Sizing Calculations: Manufacturer shall certify venting systems based on sizing calculations to be submitted for review and approval.

C. Factory authorized service personnel and routine spare parts shall be available within 24 hours of a trouble call.

D. All equipment and materials shall be new and unused.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the products-of-combustion venting system that fail in materials or workmanship within specified warranty period. Warranty periods shall be as follows:

1. Twelve (12) years from date of Substantial Completion on Category III products-of-combustion venting systems.
2. One (1) year from date of Substantial Completion on Category II & IV products-of-combustion venting systems.
3. One (1) year from date of Substantial Completion on Category I products-of-combustion venting systems.

1.6 PRODUCT HANDLING

A. Equipment to be installed shall be delivered to the site where it shall be covered and protected.

B. Products and material shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

C. Material not properly protected and stored, and which is damaged or defaced during construction, shall be replaced at no cost to the Owner.

D. Storage and protection of materials shall be in accordance with Section 23 05 00.

PART 2 - PRODUCTS

2.1 LISTED TYPE B VENT - CATEGORY I APPLIANCES

A. Vents shall be of the double-wall, factory-built type for use with approved Category I appliances burning natural or LP gas, which produce flue gases exhausted at temperatures not exceeding 480°F.

B. Vents shall be constructed of an outer wall of galvanized steel, minimum 0.018" thick G-90 for sizes 3" to 14" in diameter and minimum 0.024" thick G-90 for sizes 16" to 30" in diameter. The inner wall shall be constructed of aluminum alloy, minimum 0.012" thick for sizes 3" to 8" in diameter and minimum 0.018" thick for sizes 10" to 30" in diameter. Each vent shall include an integral, annular insulating air space, minimum 1/4" thick for sizes 3" to 6" in diameter and 1/2" thick for sizes 7" to 30" in diameter.

C. Edges of inner and outer walls shall be hemmed prior to final assembly to prevent pipe and fittings from having exposed sharp edges. Walls shall be attached to maintain spacing and prevent separation of inner and outer walls.

D. Vent pipes, 3" to 6" in size, shall incorporate a push-tab locking system to prevent disassembly of vent during or after installation.

E. Vents shall be tested and listed for a minimum clearance to combustibles of 1" for sizes 3" to 24" in diameter and 2" for sizes 26" to 30" in diameter.

F. Provide necessary components and fittings for a complete and operational vent system.

2.2 LISTED CONDENSING VENT (AL29-4C) - CATEGORY II & IV APPLIANCES

A. Vents shall be of double-wall, factory-built type for use on condensing appliances or pressurized venting systems serving Category II or IV appliances, or as specified by the equipment manufacturer.

B. Maximum temperature shall not exceed 550°F (288°C).

C. Vents shall be listed for an internal static pressure of 6" w.g. and tested to 15" w.g.

D. Vents shall be constructed with an inner and outer wall, with a minimum 1" annular insulating air space.

E. Inner walls of vents shall be constructed of AL29-4C Superferritic stainless steel, minimum 0.015" thickness for sizes 6" to 12" in diameters and minimum 0.024" thickness for sizes 14" to 24" in diameter. The outer wall (casing) shall be constructed of aluminized steel, minimum 0.018" thickness for sizes 6" to 12" in diameter and minimum 0.024" thickness for sizes 14" to 24" in diameter.

F. All duct parts exposed to the atmosphere shall be Type 304 or 316 Stainless Steel. All chimney parts that are not constructed of type 304 or 316 stainless steel and which are exposed to the outdoors (weather) shall be protected by one (1) coat of corrosion and heat resistant primer and one (1) coat of heat resistant paint. Paint shall be furnished and applied by installer.

G. Provide necessary components and fittings for a complete and operational vent system.

2.3 LISTED BUILDING-HEATING APPLIANCE/FACTORY BUILT CATEGORY III APPLIANCES AND GENERATOR SET EXHAUST

A. Provide double-wall vents tested according to UL 103 and rated for 1400°F. continuously or 1800°F for 10 minutes with positive or negative flue pressure complying with NFPA 211 and 37. These flue/exhaust systems shall be suitable for dual-fuel boilers, oven vents, domestic water heaters, or exhaust for engine/generator sets.

B. Chimneys shall be listed for an internal static pressure of 60 inches w.g.

C. Chimney sections shall be constructed of an inner and an outer wall with an annular space that will be noted on the plans. The inner wall shall be constructed of Type 304 stainless steel, minimum 0.035" thickness for sizes 6" to 36" in diameter and minimum 0.048" thickness for sizes 38" to 48" in diameter. The outer wall shall be constructed of aluminized steel, minimum 0.024" thickness for sizes 6" to 24" in diameter and minimum 0.034" thickness for sizes 26" to 48" in diameter.

D. All duct parts exposed to the atmosphere shall be Type 304 or 316 Stainless Steel. All chimney parts that are not made of 304 or 316 stainless steel and which are exposed to the outdoors (weather) shall be protected by one (1) coat of corrosion and heat resistant primer and one (1) coat of heat resistant paint. Paint shall be furnished and applied by installer.

E. Provide necessary components and fittings for a complete and operational vent system.

2.4 ACCEPTABLE MANUFACTURERS

A. Where “acceptable manufacturers” are listed, a specific product or material shall be “acceptable” (not “approved”) only if the specific product or material can evidence exact compliance with contract documents.

B. Category I appliances: Vent pipe shall be Metal-Fab Model M with Sure Lock B-Vent Locking System.

C. Category II & IV appliances: Vent shall be Metal-Fab Corr/Guard Model CG.

D. Category III appliances: Vent pipe shall be Metal-Fab Model PSW, PIC or IPIC.

E. Acceptable Manufacturers:

1. Metal-Fab, Inc. (Wichita, Kansas) or approved equals only by;
2. Van-Packer Co., Inc.
3. SelKirk Corporation
4. HeatFab
5. DuraVent

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. All flue vents/stacks/chimneys shall be handled carefully to avoid damage and be protected from exposure to the weather and dirt.

B. All flue vents/stacks/chimneys 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.

3.2 OPERATING PROCEDURES AND REQUIREMENTS

A. Provide pertinent operating and service instructions in illustrated and bound form which shall be furnished by the manufacturer, minimum three (3) copies, within 30 days of Substantial Completion with close-out documents.

B. At startup (plant assembly), the equipment manufacturer shall furnish skilled personnel to supervise, check out performance, make any required adjustments, place the venting system in service, and instruct the Owner’s personnel for a full period of one (1) hour in the care and operation of the venting systems. Start-up of heating equipment shall be performed by a service representative of the unit manufacturer. Refer to other sections of these specifications for those requirements.

C. The venting system manufacturer shall provide complete venting systems diagrams to the Mechanical Systems installer and shall provide drawings indicating all required external arrangements and connections.

3.3 EXAMINATION OF SITE CONDITIONS

A. Contractor shall examine areas and conditions at the site for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been fully corrected.

3.4 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing.

B. Seal between sections of positive pressure vents according to manufacturer’s written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories without exceeding appliance loading.

D. Slope breechings down in direction of appliance with condensate drain connection at lowest point piped to nearest drain.

E. Connect base section of foundation using anchor lugs of size and number recommended by manufacturer.

F. Join sections with acid resistant joint cement to provide continuous joint and smooth interior finish.

G. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.5 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt and construction debris and repair damaged finishes.

B. Clean breeching internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film.

C. Provide temporary closures at ends of breechings, chimneys and stacks that are to be completed or connected to equipment.

3.6 WARRANTY

A. Transfer the full Warranty to Owner to include all parts and labor for a full one (1) year period after the venting systems are put into sustained operation.

B. Transfer any and all other special warranties, as applicable, over to the Owner at the completion of construction, Substantial Completion, including any extended warranties.

END OF SECTION

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SECTION 23 52 16

CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with General Requirements in Division 01, 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 05 00.

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 as scheduled on the drawings.

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°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°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.
5. 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.

6. 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 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°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.
8. Boiler Management System (BMS):
    a. 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.

b. 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°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.

c. 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.

d. 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.

e. 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.

f. 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.

g. Connection between central BMS system and individual modules shall be twisted pair low voltage wiring, with boilers “daisy-chained” for ease of installation.

9. 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.

J. Boiler emissions shall meet all current State of Texas requirements at the time the project is bid.

K. Reference Schedule on Construction Documents for required sizes, capacities, manufacturer upon which the design was based and model numbers.

L. All boilers shall be listed for Category IV venting without exception.

M. Acceptable Manufacturers:

1. Mestek: RBI - FlexCore
2. Lochinvar - Crest
3. Aerco International – Benchmark Platinum.

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. Refer to Specification Section 23 51 23 for additional requirements.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to each site as indicated in Division 01 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 05 00.

B. Provide three (3) copies or digital copy 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

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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 as required.

1.2 SCOPE

A. Furnish each hermetic or open drive microprocessor controlled centrifugal water chilling unit economizer together with all required controls, factory unit mounted starter, pump-out unit, accessories, insulation, supports, and appurtenances as indicated herein.

B. Each chiller shall be purchased and installed by the Contractor who shall install chiller and all field installed accessories and make connection to all components, as necessary to make a complete and operational system.

C. Provide one (1) year maintenance service for the one-year warranty period and factory authorized representative start-up service. Provide an additional four 4-year warranty on the compressor after the one (1) year guarantee has expired. The first year of Warranty shall include all parts and labor.

1.3 QUALITY ASSURANCE

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

B. Equipment shall be rated in accordance with the latest edition of Air-Conditioning, Heating and Refrigeration Institute (AHRI) Standard 550.

C. Equipment and installation shall be in compliance with the latest edition of the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE Standard 15.

D. Cooler and Condenser shall include ASME "U" stamps and name plates certifying compliance with the ASME Code for Unfired Pressure Vessels, Section VIII, Division 01 when the total water side of all tubes and water boxes per vessel, contains 120 gallons, or more.

1.4 SUBMITTALS

A. Product Data:

1. Submit manufacturer's descriptive literature and installation instructions indicating capacities at the conditions scheduled and all accessories furnished.
2. Include in submittal all dimensional data, operating weight, connection points, wiring diagrams, and other pertinent performance data.
3. Submit performance data indicating energy input versus cooling load output from minimum load to 100% of full load with constant entering condenser water temperature.

B. Shop Drawings: Submit in accordance with Division 01 and Section 23 05 00.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Store and handle in full accordance with the manufacturer's instructions. Material not properly protected and stored and which is damaged or defaced during delivery or storage shall be rejected and replaced at no cost.

B. Units shall be shipped with all refrigerant piping and control wiring factory installed.

C. Units shall be shipped with metal name plate firmly attached to the unit indicating the manufacturer, model number, compressor type, and refrigerant used, including quantity of refrigerant charge.

D. Storage and protection of materials shall be in accordance with Division 01.

PART 2 - PRODUCTS

2.1 WATER CHILLERS

A. Water chilling units shall be completely factory assembled and manufactured to have the characteristics specified herein. Each unit shall have the capacity scheduled and 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 and 0.00025 fouling factor on the water side of condenser tubes. The KW power draw shall not exceed the scheduled KW per ton of cooling capacity at full load with either R-514A or R-134A refrigerants. Chiller performance shall be rated in accordance with the latest edition of AHRI Standard 550.

C. Machine shall consist of motor-compressor assembly, cooler, condenser, refrigerant transfer unit, lubrication system, microprocessor control system, and all controls necessary for automatic machine operation. Initial operating charges of refrigerant and lubricating oil shall be furnished for field installation. The unit shall also be furnished with other standard components such as transfer unit, purge unit, etc., to suit the particular unit and field installation conditions. All appurtenances shall be factory installed, wired, piped, and insulated, unless specifically indicated otherwise herein.

D. Structural steel shipping skids shall be furnished with the machine to facilitate transfer of machine from transporting conveyance to job site and to provide the most effective lifetime support for the machine. Chiller shall be installed on a structural steel base providing a level foundation. Include vibration eliminators where and as recommended and provided by the manufacturer, to include, as a minimum, elastomeric pads made of resilient cross-ribbed neoprene with steel support plates placed at each support point. Additionally, provide sole plates, leveling pads, and jacking screws under the support plates and isolation pads.

E. The unit shall be factory insulated on all cold surfaces and on adjacent surfaces as required to prevent any sweating. Use 1-1/2-inch-thick, or two layers of 3/4 inch thick, Armaflex II, paint to be all one (1) color to match unit color. Thermal conductivity shall not exceed 0.28 BTU-inch/hour-square feet-Deg.F. Contractor may field apply a second layer of insulation to comply with this requirement, however, the unit shall be initially insulated with a minimum of 3/4 inch thick insulation. Evaporator water boxes may be field insulated.

F. Variable Speed Drive (VSD)

1. The centrifugal water chiller shall be furnished with a liquid cooled variable speed drive (VSD) as shown on the drawings. The VSD shall be factory mounted on the chiller and shipped completely factory assembled, wired and tested.
2. The VSD will be specifically designed to interface with the centrifugal water chiller controls and allow for the operating ranges and specific characteristics of the chiller. The VSD control logic shall optimize chiller efficiency by coordinating compressor motor speed and compressor inlet guide vane position to maintain the chilled water setpoint while avoiding surge. If a surge is detected, VSD

surge avoidance logic will make adjustments to move away from and avoid surge at similar conditions in the future.

3. The VSD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96.
4. The VSD shall be solid state, microprocessor based pulse-width modulated (PWM) design. The VSD shall be voltage and current regulated. Output power devices shall be IGBT transistors.
5. Power semi-conductor and capacitor cooling shall be from a liquid cooled heatsink.
6. The centrifugal water chiller shall be furnished with a refrigerant cooled variable speed drive (VSD) to minimize maintenance and maximize cooling efficiency. If a water cooling design is used, especially an open loop condenser water design, a cleanable shell and tube heat exchanger must be supplied. Plate and frame heat exchangers are not allowed. The VSD shall be factory mounted on the chiller and shipped completely factory assembled, wired and tested.
7. The VSDs shall each be furnished in a NEMA 1 metal enclosure having as minimum a short circuit withstand rating of 65,000 amps per UL 508. It will include three phase input lugs plus a grounding lug for electrical connections, output motor connection via factory installed bus bars and all components properly segregated and completely enclosed in a single metal enclosure.
    a. Enclosure shall include a lockable, door-mounted circuit breaker with shunt trip and AIC rating of 65,000 amps.
    b. The entire chiller package shall be UL/CUL listed.
8. The VSD shall be tested to ANSI/UL Standard 508 and shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as designated by OSHA.
9. Compliance to recommendations stated in IEEE 519-1992.
    a. The VSD design shall include a harmonic attenuation device to limit the total demand distortion (TDD) in current at the VSD to less than or equal to 5 % as measured at the VSD input. If optional unit or remote harmonic devices are used to meet the less than or equal to 5% TDD, then the losses associated with these devices shall be included in the AHRI certified chiller selection. The chiller manufacturer must account for all electrical losses in the Kw and NPLV values submitted.
    b. Factory verification of performance and harmonics: If optional unit or remote harmonic attenuation devices are used to meet the less than 5% TDD requirement, the devices must be tested in the factory with the chiller and unit mounted VSD. In addition the less than or equal to 5% TDD must be demonstrated and chiller mounted meters or displays are NOT allowed. The distortion assessment and verification must be conducted by technicians using specific power quality instrumentation. If the chiller VSD-harmonic device fails to meet the 5% TDD level, the manufacturer shall rework the drive-harmonic device and re-test at their expense. If the VSD-harmonic device continues to fail, the manufacturer shall pay a penalty of $ 22,000.00. In addition the manufacturer shall be responsible for costs incurred on the job to obtain the additional harmonic attenuation to meet the less than or equal to 5% TDD level.
10. Input shall be nominal 480 volts, three phase, 60 hertz AC power, ± 10 percent of nominal voltage.
11. Line frequency 38-60 hertz.
12. The VSD shall include the following features:
    a. All control circuit voltages are physically and electrically isolated from power circuit voltage.
    b. 150% instantaneous torque available for improved surge control.
    c. Soft start, adjustable linear acceleration, coast-to-stop.
    d. Adjustable current limiting and UL approved electronic motor overload protection.
    e. Insensitivity to incoming power phase sequence.
    f. VSD and motor protection from the following faults: - Output line-to-line short circuit protection -Line-to-ground short circuit protection - Phase loss at AFD input - Phase reversal / Imbalance - Over-voltage - Under-voltage - Over temperature
13. The following VSD status indicators shall be available to facilitate startup and maintenance: - Output speed in hertz and rpm - Input line voltage - Input line kW - Output/load amps - Average current in percent RLA - Load power factor - Fault - VSD transistor temperature
14. Service Conditions - at full output power. No external venting or heat exchangers shall be required.

a. Operating ambient temperature 32°F-104°F.
b. Room ambient up to 95% relative humidity.
c. Elevation to 3300 feet (1000 meters). For every 300 feet above 3300 feet, the rated output current shall be decreased by one percent.

G. Compressor and Motor

1. The compressor shall be centrifugal.
2. Low pressure refrigerant machines shall be provided when available.
3. Chiller should be able to unload to 15 percent of design tonnage with constant entering water temperature. The minimum unloading point shall be demonstrated at the time of the factory performance test. The machine shall be modified to include hot gas bypass if the minimum load cannot be met.
4. Compressor assembly shall be vibration tested at the factory. Vibration shall not exceed 0.15 inches per second. The test data shall be recorded and provided to the customer for approval.
5. The motor shall be hermetic and either suction or liquid refrigerant cooled. Hot gas motor cooling is not acceptable. If an open drive motor is provided, a motor-compressor shaft seal leakage containment system shall be provided.
    a. An oil reservoir shall collect any oil and refrigerant that leaks past the seal.
    b. A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing.
    c. Manufacturer shall warrant the shaft seal, reservoir, and float valve system against leakage of oil and refrigerant to the outside of the chiller for a period of 5 years from initial start-up, including parts and labor to replace a defective seal and any refrigerant required to trim the charge to original specifications. Inspections shall be performed a minimum of once a year.
    d. Motors shall have winding RTD's for temperature sensing on each phase. These temperatures shall be furnished to the unit control panel for monitoring and alarm.
    e. Manufacturers with speed increasing transmissions shall not exceed 10,000 RPM compressor speeds and shall annually inspect the gears and all bearings. A report shall be forwarded to the owner each year over the first five years to confirm completion.
    f. The impellers shall be fully shrouded and made of a high strength aluminum alloy. Impellers shall be dynamically balanced and over-speed tested at 1.25 times impeller shaft speed.
6. Motor shall be built for connection to either a star-delta closed transition or solid-state type reduced voltage starter, furnished by the chiller manufacturer. Starter shall not allow starting current to exceed 333% of fully loaded current draw of chiller. Starters shall be unit mounted at the factory and shall be integrated with the variable frequency drive.
7. Compressor shall be of high performance, single, two or three stage centrifugal impeller design suitable for either R-514A or R-134A and include variable inlet guide vanes. Motor, transmission and compressor may be hermetically sealed. Journal bearings may be pressure lubricated.
8. Each compressor shall be provided with a factory installed forced feed lubrication system to deliver oil under pressure to bearings, transmission gears, and all rotating surfaces to include the following:
    a. Motor driven oil pump.
    b. Refrigerant Cooled Oil cooler.
    c. Oil pressure regulator.
    d. Replaceable external Oil filter, serviceable without removing refrigerant charge.
    e. Oil pump starter, factory mounted on the chiller and factory wired to pump motor and control circuit.
    f. Automatic water regulating control valve.
    g. Thermostatically controlled oil heater located in oil reservoir.
    h. Reservoir oil temperature gauge.
    i. Oil pump and heater shall be provided with a separate 460 volt, 3 phase, 60 Hz. power source served from and thru the unit mounted starter/drive.
9. Compressor motors shall be of the hermetic or open drive single speed non-reversing, continuous duty, squirrel cage induction type suitable for the voltage shown on the equipment schedule. Full load operation of the motor shall not exceed name plate rating, FLA, at design conditions. Motor

design speed shall not exceed 3,600 rpm at 60 Hz. Hermetic motors shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized sub-cooled refrigerant in contact with the motor windings. Open motors shall be suitable for operation in a Mechanical Room atmosphere. Each motor shall be arranged for service or removal with only minor compressor disassembly and without breaking of main refrigerant piping connections.

H. Evaporator and Condenser

1. Evaporator and condenser shall be horizontal shell and tube type and be provided with water boxes having vents, drains, and covers to permit tube cleaning in the space shown. Suitable tappings shall be provided in the water boxes and nozzles for control sensors and gauges. Water boxes shall be designed for 150 lb. maximum working pressure.
2. Machine construction and safety devices shall conform to the most recent ANSI B9.1 Code.
3. The shells and tube sheets shall be steel with fabricated steel water boxes.
4. Tubing shall be copper, high-efficiency type, with integral internal and external fins. Tubes shall be nominal 3/4 inch O.D. with wall thickness of 0.028 inches (22 gauge) measured at the root of the fin. Tubes shall be rolled into tube sheets and expanded into support sheets and shall be individually replaceable.
5. Units shall be designed to prevent liquid refrigerant from entering the compressor. Tubes shall be removable from either end of the heat exchanger without affecting strength and durability of the tube sheet and without causing leakage in adjacent tubes.
6. Cooler and condenser shall be horizontal shell and tube type and be provided with water boxes having vents, drains, and covers to permit tube cleaning in the space shown. Suitable tappings shall be provided in the water boxes and nozzles for control sensors and gauges. Water boxes shall be designed for 150 lb. maximum working pressure. Machine construction and safety devices shall conform with the most recent ANSI B9.1 Code. The shells and tube sheets shall be steel with fabricated steel water boxes. Tubing shall be copper, high-efficiency type, with integral internal and external fins. Tubes shall be nominal 3/4 inch O.D. with wall thickness of 0.028 inches (22-gauge) measured at the root of the fin. Tubes shall be rolled into tube sheets and expanded into support sheets and shall be individually replaceable. Units shall be designed to prevent liquid refrigerant from entering the compressor. Tubes shall be removable from either end of the heat exchanger without affecting strength and durability of the tube sheet and without causing leakage in adjacent tubes. Provide weld neck flanged nozzles for cooler and condenser piping connectors.

I. A refrigerant pump-out system shall be installed for the chiller system suitable for the high-pressure refrigerant used. Pump out system shall include compressor and drive, piping, wiring, motor starter, and a refrigerant storage vessel. The storage vessel shall be external to the unit shells and shall be large enough to hold the entire refrigerant charge. A single pump-out system with sufficient capacity for the largest chiller, may be used in a multiple chiller application. Storage receivers shall be ASME Code constructed and stamped and be furnished with relief device(s) in accordance with ANSI B9.1 Safety Code. Transfer unit and receiver shall be furnished with all necessary controls for manual operation, and shall be factory mounted, piped, and wired. Separate Pump out Systems not required when condensers can store the entire refrigerant charge and refrigerant can be isolated therein.

J. A high efficiency purge unit shall be installed for R-514A refrigerant chillers complying with all current EPA requirements. Purge unit shall be fully factory mounted, piped, and wired.

K. Economizer

1. For the Trane unit, provide economizer.
    a. Provide Trane free cooling option.
    b. Economizer shall be constructed in accordance with ASME Section VIII, Division I and consists of interstage pressure chambers which utilize a multiple orifice system to maintain the correct pressure differential between the condenser, economizer, and evaporator over the entire range of loading.
    c. When the condenser water is at a lower temperature than the chilled water, the refrigerant pressure will also be lower in the condenser than in the evaporator. This pressure difference causes refrigerant to boil in the evaporator and migrate to the condenser. The refrigerant returns to a liquid state in the condenser and flows by gravity back to the evaporator.

2. As an Alternate Bid, for a York unit, provide economizer.
    a. York economizer cycle shall consist of the evaporator, primary compressor, condenser, economizer (intercooler), economizer compressor, and accessories.
    b. Flash economizer (intercooler) shall be horizontal type with internally mounted baffles, liquid spray pipe, externally mounted level transmitter, and external control valve.
    c. The economizer compressor shall be provided with check valves on the discharge. It shall be a single-stage centrifugal type compressor similar to the main compressor.

L. Controls

1. Capacity control shall be modular and fully automatic. Module shall regulate chilled water temperature and prevent motor overload by control of the compressor guide vane positioner. Capacity modulation shall be from 100% to 10% of full load under normal operating conditions without causing surging or safety shutdown and without the use of hot gas bypass.
2. Controls shall be by a fully automatic solid state electronic microprocessor. Capacity control shall include inlet vane operator with pilot positioner. Furnish the following features:
    a. Evaporator Entering/Leaving Water Temperature Indication; °F
    b. Condenser Entering/Leaving Water Temperature Indication; °F
    c. Evaporator/Condenser Refrigerant Pressure/or Temperature Indication; PSIG/°F
    d. Oil Pressure/Temperature Indication; Low Oil Pressure Safety; PSIG/°F
    e. Evaporator/Condenser Saturation Temperature Indication; °F
    f. Motor Current Percent Indication; Motor Overcurrent Safety; % Full Load Amps.
    g. Compressor Discharge Temperature Indication; High Discharge Temperature Safety; °F
    h. Chilled Water Set point Indication and Adjustment; °F
    i. Electrical Current Limit Set point Indication and Adjustment; Amperes.
    j. Self Diagnostics
    k. Motor Controller Fault Indication
    l. Sensor Failure Indication
    m. Unit Overvoltage Safety; Volts.
    n. Unit Undervoltage Safety; Volts.
    o. Bearing High Temperature Safety; °F
    p. Low Refrigerant Temperature Safety; °F
    q. High Condenser Pressure; PSIG.
    r. High Motor Temperature; °F
3. All sensors and controls shall be factory furnished, installed, pre-piped, pre-wired, tested, and calibrated. Where required for interlock to other equipment, provide pre-wired connections for labeled terminal strips. Indication shall be by LED. Provide 24-hour battery back-up to retain all alarms and set point information. All safeties listed above shall automatically shut down unit when tripped, and shall require manual reset. This shall cause an alarm indication.
4. Controls shall be so arranged that machine cannot start unless inlet vanes are closed. The controls shall provide for a smooth pull-down of loop temperature to prevent power demand spikes.
5. Controls shall be fully automatic and shall be fail-safe. They shall include all safety controls that are standard with the manufacturer of the unit. The control center shall contain all standard components including switches, push buttons, pilot lights, and gauges.
6. Motor shall be protected against drawing more than rated full load amperes.
7. Demand limiter device shall be provided so that maximum current may be set to any percentage between 40% and 100% of full load amperes.
8. Controls shall ensure thorough lubrication of compressor, prior to start and during coast-down after machine stop.
9. After units shut-down, controls shall prevent machine restart until after a safe preset time. When shut-down, indicate time remaining until next allowed re-start at microprocessor display.
10. Motor driven non-resettable elapsed time meter shall be furnished to provide total machine operating hours.

M. Structural steel shipping skids shall be furnished with the machine to facilitate transfer of machine from transporting conveyance to job site and to provide the most effective lifetime support for the machine.

Chiller shall be installed on a structural steel base providing a level foundation. Include vibration eliminators where and as recommended and provided by the manufacturer, to include as a minimum elastomeric pads made of resilient cross-ribbed neoprene with steel support plates placed at each support point. Additionally, provide sole plates, leveling pads, and jacking screws under the support plates and isolation pads.

N. The factory unit mounted variable frequency drive shall be a closed transition star-delta or solid state starter providing single phase and 3 phase overload protection within a NEMA 1 enclosure with flush mounted 3 phase ammeter and voltmeter with four position switches and control transformer. Alternately, this capability may be provided in the chiller control panel. Provide hinged door with lock and 2 keys. Pre-wire all refrigerant auxiliaries at the factory including 120 volt, or 24 volt, single phase control circuiting.

O. The unit shall be factory insulated on all cold surfaces and on adjacent surfaces as required to prevent any sweating. Use 1-1/2 inch thick, or two layers of 3/4 inch thick, Armaflex II, paint to be all one (1) color to match unit color. Thermal conductivity

shall not exceed 0.28 BTU-inch/hour-square feet-°F. Contractor may field apply a second layer of insulation to comply with this requirement, however, the unit shall be initially insulated with a minimum of 3/4 inch thick insulation. Cooler water boxes may be field insulated.

P. Water flow sensing devices shall be provided for field installation in both chilled and condensing water lines which shall prove flow before the unit can operate. Each unit shall have externally mounted field installed, factory furnished, chilled and condenser water flow switches which shall prove sufficient flow before the unit can operate. Use 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°F to +250°F. Switch shall have 1" NPT connection for upright mounting in horizontal pipe. Paddle type switches are not allowed.

1. Alternately, a thermal dispersion flow switch, standard with the chiller manufacturer may be used which may be field or factory installed. Thermal dispersion flow switches shall be remote solid state flow monitoring systems.
2. Switches shall be equal to the “**ifm**” flow switch and shall use a remotely mounted extended length type 316 stainless steel efector (flow measuring probe) which shall be adjustable (for pipe sizes 4” and larger in diameter.
3. Switches shall have no moving parts, have a cabinet mounted control monitor, 30 feet of cable, ½” adaptor, be powered by 120 VAC, include terminal strips for ease of connection, Din-rail mountable control monitor, visual indication of flow, include LEDs for monitoring status of temperature and line breaks and include a potentiometer adjustment for calibration purposes.

Q. When the unit is energized, the oil pump shall be energized, provided protective devices are satisfied. The oil pump shall run during the machine coast down period before it shuts off. Provide momentary contacts for the oil pump to permit manual operation of pump when the compressor is off.

R. Provide automatic restart feature after a power failure/interruption to attempt a minimum of three (3) restarts after a time delay, adjustable, between restarts.

S. Provide a refrigerant sensing device to determine unsafe concentrations of the refrigerant used and contacts to indicate "safe" and "unsafe" condition to energize a purge ventilation system and to report an alarm to the Energy Management System.

T. Furnish a safety rupture disc for field piping to atmosphere.

U. Provide manufacturer furnished BacNET IP interface card. District to provide data drop at chiller for IP interface. Controls Contractor to integrate chiller controller into EMS system. Manufacturer to provide list of all available points to allow district to advise which points they would like to map to the front-end Energy Management System (EMS) graphics. Controls contractor shall include in their scope of work the

integration of these points into the EMS system and associated mapping of these points and related graphical interface.

V. Acceptable Manufacturers:

1. Trane
2. York (Alternate Bid)

2.2 MACHINE ROOM SAFETY SYSTEM

A. A ventilation system and controls shall be furnished under other sections of these specifications to meet the ventilation requirements of the most recent version of the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 15.

B. For Group A1 refrigerant machines furnish one (1) oxygen deprivation sensor and transmitter to detect oxygen levels below 19.5 percent by volume, adjustable, down to 5%, within the immediate area of the machine. In lieu of this sensor, provide separate refrigerant specific sensors and transmitters for each machine, same as noted in Paragraph 2.2.C.

C. For Group B1 refrigerant machines (R-514A) furnish a refrigerant specific sensor and transmitter for each machine to detect refrigerant concentrations as low as one (1) part per million (PPM), adjustable, within the immediate area of the machine.

D. Both oxygen deprivation and refrigerant specific sensors shall independently transmit a signal to a gas alarm monitor which shall energize the Mechanical Ventilation System and activate audible and visual alarms.

E. Coordinate chiller product data and refrigerant type with refrigerant gas detection system provider (see Section 23 09 00) to ensure the correct gas detectors are provided for the refrigerant in each chiller machine.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to the site at the specified date as indicated in Division 01, and as required to meet the scheduled completion date.

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.

3.2 INSTALLATION

A. Install unit in accordance with the manufacturer’s instructions.

B. Install connection to electrical service. Include connections to oil pump and control panel if required.

3.3 OPERATING PROCEDURES AND REQUIREMENTS

A. Four (4) copies of the operating and service instructions in illustrated and bound form shall be furnished by the manufacturer.

B. At machine start up the manufacturer shall furnish skilled factory trained personnel to supervise, check out performance, make any required adjustments, place the unit in service, and instruct the Owner's personnel for a full period of one (1) eight (8) hour day. Services shall include:

1. Leak Testing.
2. Refrigerant Pressure Testing.
3. System Evacuation (for low pressure machines).
4. System Dehydration (for low pressure machines).
5. Charge Chiller with Operating Charge of Refrigerant and Oil.

C. In addition to on-site training, manufacturer shall provide a minimum of one-day of training for up to four (4) district maintenance personnel at manufacturer's local training facility on specific operation of the chiller.

D. The manufacturer of the water chiller shall provide complete wiring diagrams to be supplied to the Electrical Systems installer and temperature controls installer and shall provide drawings indicating all required external wiring and arrangements of wiring connections to include machine room safety systems.

E. Factory authorized service personnel and routine repair parts shall be locally available within 24 hours of a trouble call.

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

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SECTION 23 73 00

INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 REFERENCED DOCUMENTS

A. Conditions of the Contract and Division 01 - 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, 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. The fans shall be controlled together as noted in the section above with common control signal, by a VFD.
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°F for chilled water and 175 PSIG at 400°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 handedness as shown on the drawings. Refer to mechanical room enlarged plans and sections for unit handedness.
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. Some units have pre-heat and re-heat coils. Refer to drawings.

I. 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 11 filters for unit operation and TAB testing as noted in filter specification.
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 filter specification with MERV 11 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.

J. 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.

K. Air Flow Measurement Station

1. An integral factory-mounted airflow measurement may be provided in lieu of a field installed air flow measuring device specified elsewhere.
2. The factory-mounted air flow measurement station shall be tested in accordance with AMCA Standard 611 for air flow measurement performance and shall be provided in the outdoor and/or return air opening to measure air flow.
3. Damper blades shall be galvanized steel, housed in galvanized steel frame and mechanically fastened to a rotating axle rod.
4. The dampers shall be rated for a maximum leakage rate of 4 CFM/ft² at 1 in w.g. complying with ASHRAE 90.1 maximum damper leakage.
5. The air flow measurement station shall be capable of measuring from 15%-100% of unit nominal air flow.
6. The air flow measurement station shall adjust for temperature variations and provide a 2-10Vdc signal that corresponds to actual airflow for controlling and documenting airflow.
7. Accuracy: +/-5%.

N. Acceptable Manufacturers:

1. Trane/Thybar.
2. Carrier.

2.2 AIR BLENDERS

A. Provide 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°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. Coordinate with air handling unit selection to get the air blender shipped to the AHU factory for factory installation.

J. Acceptable Manufacturers:

1. Blender Products, Inc. Channel Blender, or approved equal by:
2. Kees, Inc.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to each site as indicated in Division 01.

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 ensuring 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 filter specification section. 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 81 26

SPLIT DIRECT EXPANSION AIR CONDITIONERS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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 as required.

1.2 SYSTEM DESCRIPTION

A. Work shall include installing remote air-cooled condensing units, direct expansion (DX) cooling coils, and indoor blower units where indicated on the Drawings to meet scheduled capacities. Condensing units shall be matched with indoor direct expansion cooling coils mounted with upflow or horizontal blower sections.

B. Contractor shall connect all piping, refrigerant specialties. required controls, field installed accessories, appurtenances, insulation, hangers, supports, foundations, etc. to make a complete and operational system.

C. Refer to Section 23 21 13, HVAC Piping.

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 experienced mechanics and as recommended by the equipment manufacturer or as detailed.

C. All products shall meet the most current version of the International Energy Conservation Code (IECC).

D. All condensing units shall meet the Energy Star® guidelines for energy efficiency.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions and method for the configuration of equipment proposed, including wiring diagrams, piping connections, sizing and other descriptive literature necessary to evaluate the Submittals for compliance with specifications.

B. Include matched combination ratings for condensing units and indoor coils to account for refrigerant line routing and length of run.

C. Shop Drawings: Submit in accordance with Section 23 05 00.

1.5 PRODUCT HANDLING

A. Deliver all equipment to the site where it shall be covered and protected.

B. Products and material shall not be stored outside in direct exposure to sun, rain, snow, or other precipitation.

C. Equipment shall not be stored directly on the ground.

D. Material not properly protected and stored and which is damaged or defaced during construction shall be replaced at no cost to the Owner.

E. 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 qualified mechanical system installer for proper installation of equipment. Manuals shall be provided with equipment and be attached thereto.

B. Complete bound Operating and Maintenance Brochures shall be submitted a minimum of 30 days prior to completion of construction.

PART 2 - PRODUCTS

2.1 DUCT-FREE SPLIT SYSTEM

A. DUCT-FREE SPLIT SYSTEM FAN COIL UNIT

1. 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:
    a. Microprocessor controls with BACnet integration.
    b. Self-diagnostics, including compressor drive, indoor fan, and reversing valve malfunction tests.
    c. Restart function for automatic start after a power failure.
    d. Automatic air sweep.
    e. Mounting bracket and template.
    f. 3-Speed fan motor.
    g. Easy-to-remove cleanable filters; minimum one inch (1") thick
    h. Accessories, as scheduled.
    i. Electric heat strip, as applicable.
    j. Wall mounted wired thermostat supplied by manufacturer. A non-wired hand-held remote is not acceptable nor shall it substitute for a wall mounted wired thermostat.
    k. Built-in condensate pump with reservoir (when needed to route into condensate drain piping system) and sturdy high-low float switches and an overflow float switch to turn the A/C unit off. Refer to drawings for required pumping performance and units requiring condensate pump. Separate power requirement for pump is not provided.
2. Units shall be as manufactured by:
    a. Trane / Mitsubishi.
    b. Johnson Controls: York.

B. AIR COOLED CONDENSER

1. Furnish air cooled condenser 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.
2. 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.
3. 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.

4. 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.
5. 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.
6. 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.
7. 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.
8. The air cooled condenser 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.
9. All heat pumps shall have a minimum 15 SEER (ARI) at combination rating with matched DX-coil.
10. Units shall be as manufactured by:

    a. Trane / Mitsubishi.
    b. Johnson Controls: York.

C. AIR COOLED HEAT PUMP

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. All heat pumps shall have a minimum 15 SEER (ARI) at combination rating with matched DX-coil.
10. Units shall be as manufactured by:

    a. Trane / Mitsubishi.
    b. Johnson Controls: York.

2.2 DUCTED SPLIT SYSTEMS

A. HORIZONTAL FAN/BLOWER ASSEMBLIES

1. Provide upflow or horizontal direct expansion fan/blower assemblies matched to direct expansion (DX) coils and condensing units to meet scheduled capacities as indicated on the Drawings. Units are upflow or horizontal in design; refer to the Drawings for configuration.
2. Unit enclosures shall be insulated with one inch (1") thick, R value of 4.2, insulation and have panels constructed of cold rolled steel, bonderized and finished with baked enamel, or may be made of embossed galvanized steel. Large front service access panels shall provide easy access to all components.
3. Provide reversible filter rack which shall have duct connection flanges and be equipped with a permanent type filter that slides out for maintenance.
4. Fans shall be the forward curved type with double inlet, be mounted on a motor shaft, and be dynamically and statically balanced. Provide multi-speed, minimum two-speed for units 3 tons (1200 CFM) or less in capacity, or three-speed for units over three tons in size (above 1,200 CFM), permanent-split-capacitor (PSC) fan motors. Motors shall be factory lubricated, have internal overload protection, and be resiliently mounted. Fan motor assembly shall slide out for service.
5. Acceptable Manufacturers:
    a. Trane / Mitsubishi.
    b. Johnson Controls: York.

B. DIRECT EXPANSION (DX) COOLING COILS

1. Furnish and install A/C Unit Direct Expansion (DX) cooling coil modules to meet capacities scheduled to be matched with condensing units as detailed and shown on the Drawings. Units shall be upflow or horizontal design as indicated on the Drawings.
2. Unit enclosures shall be fully insulated and constructed of cold-rolled steel, bonderized and finished with baked enamel.
3. Cooling coils shall be constructed with aluminum plate fins mechanically bonded to non-ferrous copper tubing with all joints brazed. Coils shall have factory installed refrigerant line fittings which permit mechanical connections and condensate pans with primary and auxiliary drain connections on each side. Coil pressure drop scheduled shall not be exceeded. Include factory installed expansion valve.
4. Provide an enhanced dehumidification accessory with thermal expansion valve constructed similar to the cooling coil, downstream of the cooling coil, to be used for hot gas reheat during dehumidification purposes where called out on equipment schedules.
5. Coil modules shall be as manufactured by:
    a. Trane / Mitsubishi.
    b. Johnson Controls: York.

C. ELECTRIC HEATING SECTION

1. Where scheduled on drawings, provide a factory installed electric heater.
2. Heater shall have the capacities, electrical characteristics, and stages as indicated on the drawings.
3. All heaters shall be ETL approved and have single point electrical power wiring terminal blocks.
4. Provide a hinged service access panel to the electrical heating section.
5. Electric heat modules shall be installed in unit.
6. Electric heater elements shall be constructed of heavy-duty nickel chromium elements internally connected for the scheduled electrical requirements.
7. Staging shall be achieved through the unit control processor.
8. Each heater package shall have automatically reset high limit control operating through heating element contactors.
9. All heaters shall be individually fused from factory, and meet all NEC requirements when properly installed.
10. Electrical heat modules shall be UL listed or CSA certified.

D. AIR COOLED CONDENSING UNITS

1. Furnish air cooled condensing units, as scheduled on the Drawings. Brass service valves with refrigerant line fittings and service ports shall be located on the exterior of the unit. Each unit shall be fully assembled and tested at the factory. It shall be designed for use with Refrigerant 410a.
2. Capacities shall be as scheduled, with submitted equipment capacities based on combination ratings for the matched indoor coil, condensing unit, blower, and installation conditions shown on the Drawings including accounting for refrigerant line losses.
3. Condensing coils shall be of non-ferrous (copper) construction above a nominal 5-ton capacity and aluminum or copper below five (5) tons. Aluminum coils shall be warranted for five (5) years. Coils shall have aluminum plate fins, mechanically bonded to the coil tubes. Coils shall be provided with the manufacturer's furnished, field installed, heavy duty condenser coil air inlet hail and vandal guards/grilles.
4. Units shall be furnished with direct driven, propeller-type condenser fans arranged for vertical air discharge. Condenser fan motors shall have inherent thermal overload protection, shall be the permanently lubricated type, and be resiliently mounted. Each fan shall have a discharge corrosion resistant safety guard. Motors shall be the totally enclosed fan cooled type (TEFC) and permanent-split-capacitor type.
5. Compressors shall be of the welded-hermetic type with internal vibration isolation. Compressor motor shall have both thermal and current sensitive overload devices, and start assist capacitance devices shall be standard on single phase units, where the refrigerant line length exceeds 50 feet in total equivalent length (one way). Compressors shall be equipped with a crankcase heater and have internal high-pressure protection.
6. Controls and protective devices shall include a liquid line low-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.
7. Accessories shall include Solid-State Time Guard, Liquid Line Filter Dryer, sight glass, Flare-to-Compatible Coupler, crankcase heater (for low ambient (below 55 Deg.F.) and long line (over 50 feet) applications, evaporator freeze protection thermostat (low ambient (below 55 Deg.F.) operation), winter start control (low ambient applications and with low pressure switch), and a head pressure controller to allow operation down to 20 Deg.F. ambient temperature.
8. Air cooled condensing units shall carry the full one (1) year warranty on the entire unit, plus, an additional four (4) year parts only warranty on the motor compressor unit.
9. All condensing units shall have a minimum SEER of 13.0, as applicable, at combination rating with matched DX-coil and furnace/blower section.
10. Designated units require humidity control. Refer to equipment schedule. Two (2) options will be considered. One is by use of an Enhanced Dehumidification accessory (EDA) which includes a hot gas reheat coil. This option will only be allowed if it can fit the available spaces. The second option would be as follows:

    a. Furnish APR Control for capacity control in split system air conditioning applications.
    b. APR Controls shall be as manufactured by Rawal Devices, Inc. Of Woburn, MA (800-727-6447/fax 781-933-3306) and shall be installed on designated systems to provide continuos capacity modulation on the refrigeration circuits for additional capacity (first on/last off) in systems with multiple circuits for staging. In systems with tandem or manifold compressors, APR with multiple circuits for staging. In systems with tandem or manifold compressors, APR Control shall be installed across piping connections where the compressor’s piping combine to create the single circuit.
    c. The APR Control is to be installed in the condensing unit section of the system in accordance with Rawal Devices, Inc. installation instructions and as directed by Rawal Devices, Inc. Engineers. ASHRAE refrigeration piping and Equipment Manufacturer’s piping protocol shall be adhered to when the APR Control is applied to split systems.
    d. The APR control hot gas bypass valve shall be set at 64 psi to maintain the evaporator coil above 36 Deg.F. at all times. The liquid injection valve shall be at 17 Deg.F. superheat, and shall function as a compressor overheat protection device. The patented vortex desuperheat chamber shall have an access valve to allow pressure testing, evacuation and charging of the system. APR Controls come factory preset, but must be confirmed in the field. Adjustment instructions are provided with the APR Control installation documentation.

e. Refrigeration ball valves shall be installed on all connections to the APR Control device to allow isolation of the APR Control during charging and start-up of the systems to which the APR Controls are applied.
f. The APR Control is a field installed device and shall be sized by Rawal Devices, Inc. Engineers or authorized Dealer to assure proper application. Contact Rawal devices, inc. Engineers to confirm proper selection.

11. Acceptable Manufacturers:

a. Trane / Mitsubishi.
b. Johnson Controls: York.

E. AIR COOLED HEAT PUMP

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. All heat pumps shall have a minimum 15 SEER (ARI) at combination rating with matched DX-coil.
10. Units shall be as manufactured by

a. Trane / Mitsubishi.
b. Johnson Controls: York.

F. CONTROLS

1. Coordinate controls with Section 23 09 00 Controls Contractor.
2. Provide microprocessor controller for integration with building automation system through BACnet MS/TP protocol.

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. 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.

3.2 AIR COOLED CONDENSING UNIT INSTALLATION

A. Install condensing units level on roof supports where shown with vibration pads beneath unit legs.

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. Charge all refrigerant piping systems and equipment to maintain a fully operating refrigerant and oil charge.

3.3 OPERATING PROCEDURES AND REQUIREMENTS

A. Three (3) copies of the operating and service instructions, in illustrated and bound form, shall be furnished by the manufacturer.

B. The manufacturer of each item of equipment shall provide complete power and wiring diagrams to the Electrical and Control Systems installers, respectively. Drawings shall show all required external wiring and arrangements of electrical connections.

3.4 START-UP AND TRAINING

A. Provide a factory representative to start up equipment in the presence of the Owner. Give the Owner a 72-hour notification of this event.

B. A factory representative shall train the Owner in start up of the equipment. A sign-in sheet shall record the training and this sheet shall be included in the close out documents.

3.5 WARRANTY

A. Transfer all Warranties to Owner for a full one (1) year period after the A/C systems are put into sustained operation to obtain building cooling effect for the benefit of occupancy by the Owner, Substantial Completion.

B. Transfer any and all other warranties as applicable over to the Owner at the completion of construction, Substantial Completion, including extended four (4) year compressor warranties, as applicable, on refrigeration equipment.

END OF SECTION

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SECTION 23 82 39

UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 01 - 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 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 01 and Section 23 0500.

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°F to 90°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° 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. Q-Mark.
2. Trane.
3. Reznor.
4. Modine.
5. Emerson.
6. Markel.
7. BERKO.

2.2 FORCED AIR ELECTRIC CEILING HEATERS

A. Provide forced air electric ceiling heaters of the capacities, characteristics, and sizes as specified herein and as indicated on the Drawings.

B. Enclosures shall be constructed of reinforced 16-gauge steel to withstand heavy institutional use.

C. Heating elements shall be steel sheath, enclosed, with base of metal fins rippled and furnace-brazed to sheath. Thermal overheat protection shall be line voltage type with automatic reset thermal overloads to turn heating elements off, should overheating occur, such as due to accidental blockage. Operation shall automatically restore when cause for overheating is eliminated.

D. Each cabinet convector shall be completely factory assembled, wired, tested and shipped as a single assembly.

E. All cabinet convectors and electrical accessories shall be listed by Underwriters Laboratories, Inc.

F. Enclosure shall be chemically treated to resist corrosion and be finished in a baked enamel, color as selected by Architect. Finish shall be mar and temperature resistant.

G. Ceiling heaters shall be suitable for recessed mounting, adjustable recess frame.

H. Heater shall contain built-in fan delay switch to energize fan motor only after elements are heated to prevent discharge of unheated air. When heat shuts off, switch shall de-energize fan motor only after residual heat has been dissipated.

I. Acceptable Manufacturers:

1. Q-Mark.
2. Trane.
3. Markel.
4. BERKO.
5. Chromalox.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

A. Deliver all equipment to each site as indicated in Division 01.

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

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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 CUTTING AND PATCHING

A. When cutting or patching becomes necessary to permit the installation of any work under this contract, or should it become necessary to repair any defects that may appear in patching up to the expiration of the guarantee, such cutting shall be done under the supervision of the Architect by the trade or Contractor whose work is to be disturbed. After the necessary work has been completed, damage shall be repaired by the Contractor or trade whose work has been disturbed. The cost of all such cutting and patching shall be paid by the Contractor requiring it to be done.

1. Refer to Division 1 requirements.

B. The Contractor shall do all necessary cutting and drilling of walls, floors, ceilings, etc. for the installation of new work or for modifications to the existing work, but no structural work shall be cut unless specifically approved by the Architect. Patching and painting of services as required shall be by the General Contractor unless specified otherwise hereinafter.

C. The Contractor shall examine the plans for the new work and note the sizes of the openings available and shall be responsible for any cutting, patching, and alterations required to place new equipment in the building.

D. Where walls, acoustical tile, suspended ceilings, etc., not scheduled to be re-worked or re-finished under the general contract are damaged during installation of new raceways, or other work, etc., such walls, tiles, etc., shall be replaced by the General Contractor at the expense of the Contractor.

E. All damage done to the existing equipment, services, etc., incurred in the execution of this contract shall be repaired and restored to its original conditions by the Contractor.

F. Holes through concrete shall be drilled with "Mole", or "Core-It", or equal diamond point hole saw.

1.7 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.

1.8 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.

1.9 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.

1.10 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.

1.11 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 Division 1.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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.

1.20 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.

1.21 CLEANING UP

A. The Contractor shall be responsible for cleaning up his work as specified in the General Requirements of these Specifications.

1.22 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.

1.23 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. Furnish, at the completion of the job, a final Inspection Certificate from the local inspecting authority.

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. 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 01

ELECTRICAL DEMOLITION

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. Contractor shall remove several items of materials and equipment under this section of the specifications. Equipment and materials to be removed shall be as indicated and noted on the Drawings and as required to facilitate the new installations.

B. Provide labor, materials, equipment, tools and services as required to complete the demolition work indicated.

C. Refer to Division 1 for "Schedule of Work".

1.3 DISRUPTION OF EXISTING FUNCTIONS

A. 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.

B. Disruptions: Maintain existing lighting, power, telephone, and other systems, and maintain existing functions in service, except for scheduled disruptions as allowed in Division 01, "General Conditions".

C. Provide all temporary connections as necessary to facilitate the phasing of construction.

1.4 SALVAGE, DEMOLITION, AND RELOCATION

A. It shall be the responsibility of the Contractor to remove and store those items of existing equipment as indicated on the Drawings to be removed. All items of equipment or fixtures removed shall be protected from damage insofar as is practical.

B. These items shall be stored on site for a minimum of two (2) weeks unless indicated otherwise by the Owner's representative to allow for inspection by the Owner. Deliver, all items tagged to be retained by the Owner to a designated storage location on site or to the Owner's designated Service Center or Warehouse. All items not retained by the Owner shall be removed from the site by the Contractor at no additional cost to the Owner.

C. The attendant conduit, hangers, foundations, etc., of those items of existing equipment to be removed, shall also be removed in their entirety. No hangers, etc., shall be abandoned in place.

D. Relocations:

1. Repair and restore to good functional condition materials and items scheduled for relocation and/or reuse and which are damaged during dismantling or reassembly operations.
2. New materials and items of like design and quality may be substituted for materials and items indicated to be relocated, in lieu of relocation, upon approval of shop drawings, product data and samples.
3. Remove carefully, in reverse to original assembly or placement, items which are to be relocated.
4. Protect items until relocation is complete.

5. Clean and repair and provide new materials, fittings, and appurtenances required to complete the relocation and to restore to good operative order.
6. Perform the relocation work in accordance with pertinent sections of the specifications, utilizing skilled workers.
7. Refer to Drawings for specific requirements of temporary services and relocated equipment and fixtures.
8. Coordinate with the General Contractor repairs required to bring finishes back to their original conditions after demolition and or installation of new equipment.

1.5 CLEAN UP

A. Remove all debris, rubbish, and materials resulting from cutting, demolition, or patching operations from the work area on a daily basis.

B. Transport materials and legally dispose of off site.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials and equipment for patching and extending work as specified in individual sections or as indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Field Conditions: Demolition Drawings are based on non-invasive field observations and existing record documents. Report discrepancies in location, dimensions or quantity to Owner and Architect prior to disturbing existing installation.

B. Abandoned Wiring: Verify that abandoned wiring and equipment serve only facilities scheduled for demolition.

C. Existing Conditions: Commencing demolition means Contractor accepts existing conditions.

3.2 PREPARATION

A. Demolition: Disconnect electrical systems in walls, floors, ceilings and equipment scheduled for removal.

B. Project Coordination: Coordinate utility service outages with utility companies and schedule work with Facility management and Owner.

C. Temporary Wiring: Provide temporary wiring and connections as necessary to maintain existing systems in service during construction.

D. Schedule installation of temporary wiring and connections to eliminate hazard to installing personnel.

1. When work must be performed on energized circuits or equipment, use qualified personnel experienced in such operations.
2. Submit "hot work" policy information to Architect for review prior to performing work on any energized circuits.

E. Electrical Service: Maintain existing system in operation until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission, in writing, from Owner prior to partially or completely disabling system. Minimize outage duration. Make temporary connections as necessary to maintain service to areas unaffected by the scope of Work.

F. Telephone Service: Maintain existing system in operation until new system is complete and has been accepted. Disable system only to make switchovers and connections. Obtain permission, in writing, from Owner, and notify the utility company, prior to partially or completely disabling system. Minimize outage duration. Make temporary connections as necessary to maintain service to areas unaffected by the scope of Work.

G. Special Systems: Maintain existing systems in operation until new systems are complete and have been accepted. Disable systems only to make switchovers and connections. Obtain permission, in writing, from Owner prior to partially or completely disabling systems. Minimize outage duration. Make temporary connections as necessary to maintain service to areas unaffected by the scope of Work.

1. The following systems will be affected by the scope of Work:

a. Fire Alarm System
b. Public Address System
c. Security System
d. Data System

3.3 DEMOLITION AND EXTENSION OF EXISTING WORK

A. General: Demolish and extend existing work as indicated or described in the Drawings and Specifications.

1. Lighting fixtures and electrical distribution equipment shall be salvaged for possible re-installation as directed by the Owner and Architect.

B. Wiring: Remove abandoned wiring and cables to source of supply or termination.

C. Raceways:

1. Remove exposed abandoned conduits and raceways, including abandoned conduits and raceways above accessible ceilings.
2. Conduits and raceways concealed in existing construction to remain shall be abandoned in place. Cut conduits and raceways such that finished surfaces can be patched smooth.

D. Wiring Devices: Remove abandoned wiring devices. Provide blank device plates for outlet boxes not being removed.

E. Electrical Distribution Equipment: Disconnect and remove abandoned panelboards and electrical distribution equipment.

F. Lighting Fixtures: Disconnect and remove abandoned lighting fixtures, including brackets stems, hangers and other accessories not indicated to be re-used.

G. Existing Installations to Remain: Maintain access to existing electrical installations which remain active.

H. Modify installation or provide access panel as required.

I. Extension of existing circuits: Extend existing installations as required to maintain service to items to remain using materials and methods, as specified that are compatible with original installation.

J. Adjacent Construction: Repair adjacent construction and finishes damaged during demolition and extension work.

K. Dispose of hazardous materials, such as fluorescent and H.I.D. lamps and PCB's in lamp ballasts, in accordance with all Local, State and Federal ordinances and regulations.

3.4 SALVAGED MATERIALS

A. Salvage existing materials for re-installation as directed by Owner. Coordinate locations for storage of salvaged materials with Owner.

3.5 CLEANING AND REPAIR

A. Existing Materials: Clean and repair existing materials and equipment which remain or are to be re-used.

B. Existing Switchboards and Panelboards: Clean exposed surfaces and check tightness of all electrical connections. Replace damaged circuit breakers with units of compatible construction and provide closure plates for vacant positions.

C. Existing Lighting Fixtures: Where existing lighting fixtures are indicated to remain, clean reflector and lens and replace lamps.

1. Use mild detergent to clean all interior and exterior surfaces; rinse with clean water and wipe dry; allow to dry thoroughly prior to re-installation.
2. Replace lamps and broken electrical components. Replace cracked or broken lenses and louvers with new identical materials.
3. Ballasts: Replace ballasts in all fluorescent lighting fixtures to remain or to be re-used with new ballasts as specified.

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 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. Where specifically noted on the drawings, permitted by the NEC and local ordinances, Type UF cable assemblies shall be permitted for underground branch circuit wiring.

C. For final connections from junction boxes mounted on the building structure to recessed lighting fixtures and smoke dampers. 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. 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

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

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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.

C. Provide connections from the grounding electrode system to:

1. The electric power system grounded circuit conductor (neutral).
2. The electric power system non-current carrying enclosures and equipment ground conductors (equipment ground).

D. 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 domestic cold water piping shall be Thomas and Betts GUV Series copper alloy U-bolt and mechanical clamp.

D. Connections to building structural steel shall be exothermic weld equal to Cadweld.

E. 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.
6. All circuits shall be grounded at all junction boxes.

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

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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

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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

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. PVC Coated Metallic Conduits: Plastibond, Permacote, and Korkap.

3. 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.

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. 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.

F. Elbows and Bends:

1. Rigid nonmetallic conduit systems: Rigid metal electrical conduits.
2. Other Conduit Systems: Same material as the conduit with which they are installed.
3. All Types: Size 1-1/4 inch and larger shall be factory manufactured.

G. 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.

H. 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.

I. Hubs: Cadmium plated malleable iron, tapered threads, neoprene "O" ring, insulated throat, O-Z/Gedney.

J. E.M.T. Compression Connectors: Gland compression type, zinc plated steel body, cadmium plated, malleable iron nut, insulated throat, O-Z/Gedney.

K. E.M.T. Compression Couplings: Gland compression type, zinc plated steel body, cadmium plated malleable iron nut, O-Z/Gedney.

L. Liquidtight Conduit Connectors: Cadmium plated malleable iron body and nut, cadmium plated steel ferrule, insulated throat, integrally cast external ground lug, O-Z/Gedney.

M. 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.

N. Seals for Penetrations through Existing Walls: Thunderline Corporation Link-Seal watertight sleeves, complete with wall and casing seals.

O. Fire Seals: Galvanized iron pipe sleeves sealed with approved foam type fireproofing.

P. Expansion Fittings: Hot-dipped galvanized malleable iron with bonding jumpers selected for linear or linear with deflection, as required.

Q. Escutcheons: Chrome plated sectional floor and ceiling plates, Crane No. 10.

R. Accessories: Reducers, bushings, washers, etc., shall be cadmium plated malleable iron on the forms and dimensions best suited for the application.

S. 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 if larger than 2” size. Set screw fittings allowed on conduits up to 2” size and only if steel connectors are used.

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. Install rigid metal electrical conduit for all uses in hazardous areas, in locations subject to physical damage, and for feeder sizes 2-1/2" and larger.

T. Apply two (2) coats of bituminous paint to all portions of rigid metal conduits in contact with concrete and/or the ground.

U. Install electrical metallic tubing for branch circuits concealed in walls and above ceiling and for feeder sizes 2" and smaller.

V. Where permitted by authorities having jurisdiction, flexible metal conduit may be used for final connection to individual light fixtures from junction boxes mounted on, or suspended from, the building structure. Maximum length shall be 6'-0", minimum of 3'-0". Minimum size shall be 1/2". Flexible conduit connections between light fixtures are not allowed.

W. Use liquid-tight flexible conduit in damp and wet locations, and in food service connections.

X. 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.

Y. Provide pullstring in each empty conduit. Label pullstring when conduit termination is not obvious.

Z. Install rigid non-metal electrical conduit for all uses in damp and wet locations and in crawlspaces.

AA. Use schedule 40 PVC for all primary and secondary service conduits and conduits in crawlspaces. Use galvanized steel long radius elbows.

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. Floor Outlet Boxes: Hubbell cast flush floor boxes, fully adjustable with flush service fitting, and carpet flange (if required).

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

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SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS 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. This Section includes the following: Conduit, ducts, and duct accessories for concrete-encased duct banks.

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 32 - Raceways
5. 26 05 53 - Identification for Electrical Systems

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 REFERENCE STANDARDS

A. UL 6 - Rigid Metal Electrical Conduit

B. UL 514B - Fittings for Conduit and Outlet Boxes

C. UL 651 - Schedule 40 and 80 Rigid PVC Conduits

D. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

E. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

F. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

G. ANSI C80-1 - Rigid Steel Conduit - Zinc Coated (GRC)

1.5 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Warning tape.

B. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner at least two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of ducts, handholes, and manholes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes, and as approved by Architect and the Civil Engineer.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCT ACCESSORIES

A. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

3.2 ABOVE GROUND CONDUIT

A. Rigid steel, galvanized, complying with ANSI C80.1.

B. Install voltage markers.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.

B. Curves and Bends: Use 5-degree angle couplings for slight changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

I. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

1. Concrete for communications ducts shall be 3,000 psi gray.
2. Concrete for electrical ducts shall be 3,000 psi red.

J. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

1. Stirrups shall be #4 bars.
2. Reinforcing shall be #3 bars.

K. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

L. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.

M. Depth: Install top of duct bank at least 36 inches below finished grade.

N. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

1. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
2. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

O. Warning Tape: Bury warning tape approximately 18 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

P. Underground duct lines which penetrate building exterior walls shall include a subterranean seal.

Q. All stub-ups of PVC conduit runs shall be made with rigid galvanized steel conduit with protective wrapping. Provide corrosion resistant protective wrapping from where the galvanized conduit begins to 4” above finished concrete.

3.5 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Notify architect at least 24 hours in advance of concrete duct pour.

3.7 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of hand holes. Remove foreign material.

END OF SECTION

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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 Transformers.
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. 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.

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 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.

3.6 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.

3.7 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.

3.8 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

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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 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 Guide for Determining Energy Efficiency for Distribution Transformers

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
3. Eaton
4. Siemens

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 - 45dB
2. 51 to 150 KVA - 50dB
3. 151 to 300 KVA - 55dB

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.

E. Transformers shall not be stacked.

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.
3. Eaton.
4. Siemens.

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 Switch Board

1. Two-step stored energy electronic trip molded case circuit breakers

a. Individually fixed mounted through 3000 A

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 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.

a) 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.

2.3 SWITCHBOARD - DISTRIBUTION SWITCHBOARDS

A. Branch Circuit Breakers

1. Thermal magnetic molded case circuit breakers, for ratings 250 amperes and less.
    a. Group mounted.
        1) Circuit protective devices shall be molded case circuit breakers. Circuit breakers shall be standard, high, or extra high interrupting capacity, or true current limiting as indicated on the drawings.
2. Electronic trip molded case standard function 80% rated circuit breakers.
    a. Group mounted 300 amperes 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.

2.4 INSTRUMENTATION

A. Provide a Square D Class 3020 PM820 PowerLogic Power Meter with display for the load side of each switchboard main breaker and tie breaker. Devices by others will be considered providing all the following specifications are met.

B. The information displayed by the Power Meter shall include the following quantities:

1. Current, per-phase
2. Volts, phase-to-phase & phase-neutral
3. Real Power (kW), three-phase total
4. Reactive Power (kVAR), three phase total
5. Apparent Power (kVA), three phase total
6. Power Factor, true, per-phase & three-phase total
7. Frequency
8. Current Demand, per phase and neutral, present and peak
9. Real Power Demand (kWd), three phase total, present and peak
10. Reactive Power Demand (kVARd), three phase total, present and peak
11. Apparent Power Demand (kVAd), three phase total, present and peak
12. Real Energy (kWh), three phase total
13. Reactive Energy (kVARh), three phase total
14. Apparent Energy (kVAh), three phase total
15. Energy Accumulation Modes, signed, absolute, energy in, energy out
16. Watt-hour KYZ Pulse Initiator Output
17. Total Harmonic Distortion, Voltage
18. Total Harmonic Distortion, Current
19. Date/Time Stamping.

20. Communications port for Power Monitoring Systems communications and Modbus RTU communications.

C. The Power Meter shall be accurate to .25% for voltage and current sensing, .50% for power, energy, & demand sensing, and 1% for power factor sensing.

D. All information stored in the Power Meter shall be remotely accessible through data communications.

E. The Power Meter shall be UL Listed, rated for an operating temperature range of 0 C to 55 C and have an overcurrent withstand rating of 500 amps for 1 second.

F. The Power Meter metering inputs shall utilize industry standard current transformers (5A secondary CT's), have VT inputs for direct connection of VT leads to up to 600V, and adhere to UL standard 508 for dielectric voltage-withstand.

G. The data communications shall be optically isolated to provide reliable operation.

2.5 SURGE SUPPRESSION DEVICE (SPD)

A. Provide SPD protection on the load side of the main breaker as 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 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

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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.
3. Eaton.
4. Siemens.

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. rated 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 nearly 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 pullcord 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

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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. Electrica: 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

A. Square D

B. General Electric

C. Eaton

D. Siemens - ITE

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.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless noted otherwise, wiring devices shall be standard industrial grade devices, ivory 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, ivory 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, P&S PS20AC1.
2. Three way wall toggle, P&S PS20AC3.
3. Four way wall toggle, P&S PS20AC4.
4. One hour spring wound wall timer switch, without hold tork #560M, 120 volt.
5. Six hour spring wound wall timer switch, without hold tork #506H, 120 volt.

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.
3. 125V, 30A, 5-30R, Simplex, Leviton 5371, P&S 3802.
4. 125/250V, 10-30R, Simplex, Leviton 5207, P&S 3860.
5. 125/250V, 5-20R, Simplex Clock Hanger, Leviton 5361-CH. 5-15R P&S S3713.

D. Isolated Ground Receptacles

1. 125V, 20A, 5-20R, Duplex, Industrial grade, Leviton 5362-IG. P&S 1G5362.

E. 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 and light switch shall be provided with an indelible marker giving the panelboard and branch circuit number supplying the outlet located on back side of cover plate.

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

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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.

END OF SECTION

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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.
3. Eaton.
4. Siemens.

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

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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:

1. For 120/208 volt systems, 700 volts L-N, L-G, N-G and 1200 volts L-L.
2. For 277/480 volt systems, 1200 volts L-N, L-G, N-G and 1800 volts L-L.

C. The Maximum Continuous Voltage Rating (MCOV) shall be not less than 115% of the nominal system operating voltage.

D. The I-Nominal rating shall be not less than 20 KA.

E. The units shall have not more than 10% deterioration or degradation of the VPR due to repeated surges.

F. 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

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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 00 - Electrical
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 51 05 - 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 product data under provisions of section 26 00 00 Electrical.

B. 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.

C. 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.

D. Submit samples of fixtures upon specific request.

E. Certificates: Labels of Underwriters' Laboratories, Inc.; affixed to each item of material.

F. Provide closeout documents as required in Division 1.

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.
4. The contractor shall coordinate light fixture mounting frames and accessories with the ceiling type actually being furnished. Refer to final Architectural Reflected Ceiling Plan and related submittals prior to confirming mounting frames and accessories. Light fixture submittals shall be based on this level of coordination occurring prior to submittals being generated by the contractor.

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

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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 controls system with networked devices. Provide full web based central control software with lighting controls graphical user interface from an owner’s networked PC.

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
6. 26 51 02 - Exterior 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. Submit product data under provisions of section 26 00 00 Electrical.

B. 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.
6. Sample graphical user interface showing sample home page, floor plan graphics with lighting control zones, and sample scheduling and override features.

C. Provide closeout documents as required in Division 1.

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. Signify.
3. Lutron.

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 provide time-based, sensor-based (both occupancy and daylight), 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. All system devices shall be networked together, enabling digital communication between devices, and shall be individually addressed.
4. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity, even if network connectivity to the greater system is lost.
5. The system architecture shall facilitate remote operation via a computer connection.
6. The system shall not require any centrally hardwired switching equipment.
7. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

B. System Requirements:

1. System shall have an architecture that is based upon three main concepts: 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time-based operation.

2. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
3. 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).
4. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
5. 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.
6. 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 NETWORK BRIDGE MODULE

A. The network bridge module allows multiple room controller zones to be networked with other system devices for whole building administration of lighting control functions.

B. The bridge shall connect to and be powered from a room controller smart port via a standard plenum rated Cat5 cable.

C. Two additional RJ-45 ports on the bridge shall provide an in and out connection point for an Ethernet based network.

D. The network bridge module shall provide a communication link between the room control devices and the system area controller via an Ethernet based network. At a minimum, the network link shall provide the following functionality through a web browser user interface:

1. Report the current occupancy status for each lighting control zone.
2. Indicate the status of each relay and dimming channel.
3. Allow reconfiguration of system device input and output parameters.
4. Report the real time power consumption for each Room Controller.
5. Set up daylight harvesting for zones equipped with photocells.
6. Configure and download schedules to panels and Room Controllers.

2.4 LIGHTING CONTROL PANELS

A. Panels shall be configured with the quantity of relays and 0 - 10 volt dimming channels as indicated.

B. Functional:

1. The lighting control panels shall be of the distributed intelligence type and shall not be dependent a network connection to execute schedules or perform programmed functions.
2. Relays, dimmers, and low voltage inputs shall be assignable to control zones as required via the web browser user interface.
3. Each panel shall have low voltage input terminals for connection of Class 2 devices.
4. Inputs shall be programmable to support momentary or maintained contact types and shall provide for alternate action on/off, on only, off only, raise, lower, timed on or preset recall operation.
5. Each panel shall provide capability to control external devices through integral form-C low voltage contacts.
6. Dimming outputs shall be industry standard 0 - 10-volt current sinking type and provide continuous dimming for compatible dimming ballasts and LED drivers.
7. Dimming channels shall be assignable to control zones as required via the web browser user interface.
8. Dimming channels shall be configurable to respond to manual raise/lower wall switch control stations, preset scenes, or daylight harvesting photocells.

2.5 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.

2.6 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.

2.7 DAYLIGHT SENSORS

A. Daylight sensors shall provide ambient light level information to the room controller allowing daylight responsive lighting control.

B. The system shall operate in an open loop sequence of operation reducing the amount of electric light as the quantity of daylight entering the room increases.

C. It shall be possible to configure up to six daylight zones in a room. Each zone shall be programmable to proportionally respond to the light level provided by the daylight sensor.

D. The daylight sensor shall be mounted and positioned to provide an unobstructed view of the windows per the manufacturer's directions.

2.8 AREA CONTROLLER

A. Web browser-based system programming, monitoring and administration shall be provided by the area controller.

B. The Area Controller shall have the ability to communicate by means of TCP/IP over Ethernet allowing enterprise connectivity between the NX Distributed Lighting Control System and external LAN or WAN networks.

C. Provide integral capability to communicate with the Building Automation System via BACnet MS/TP protocol.

2.9 EXTERIOR WIRELESS LIGHTING CONTROLLERS

A. All wireless lighting controllers shall provide the following features and capabilities:

1. 0-10VDC (sinking) dimming control in 0.1V increments based on LED driver high and low operating range; 0V turns fixture power OFF.
2. Direct motion detector interface/motion detector input when required.
3. Scheduled control.
4. Over the air flashing (program updates).

B. Wireless Outdoor Lighting Controller (externally top mounted)

1. Nodes shall be a one-piece, self-contained IP66-rated device, externally mounted, capable of providing 0-10VDC dimming, bi-level and on and off control to luminaire with the following features:
    a. Twist lock mounting via NEMA ANSI 136.41 7-pin connector.
    b. Controller shall consist of a completely self-contained distributed intelligent wireless lighting controller capable of functioning completely independently including time based and

astronomical scheduling of On/Off and preset events without the need of any coordinator, gateway of master controller.

c. Controller shall be configurable remotely over the air utilizing built in Bluetooth radio an iOS or Android handheld device or via Wireless HUBBnet network.
d. Controller shall be capable of having its device firmware updated wirelessly.
e. Controller shall include non-volatile memory for retaining device settings during power outages.
f. Controller shall include an integrated daylight sensor.
g. Controller shall support universal input voltage (120-480VAC, 50/60Hz).
h. Controller shall include one SPST relay for On/Off control.
i. Controllers shall communicate with each other via wireless mesh network.
j. Controller shall include non-volatile memory for retaining device settings during power outages.
k. Controller shall UL Listed to UL916 and Certified to CAN/CSA C22.2 NO 205-M1983.
l. Controller shall be FCC certified.

2.10 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 ensure that emergency lights are automatically turned full on upon loss of normal power to the area.

2.11 WEB BASED CENTRAL CONTROL SOFTWARE

A. Web based Central Control Software: Central control software application is used to commission, configure and manage the system. Every system parameter in the building and associated exterior areas is configured for each individual user or space and baseline settings are established for each of the following (depending on the basis of design) system features:

1. Daylight harvesting.
2. Occupancy control.
3. Smart time scheduling.
4. Task tuning.
5. Personal control.
6. Load shedding.

B. Software utilizes a web-based interface that permits a user to easily navigate between zones, floors or different buildings and allows a user to zoom in or zoom out of specific areas of a building. Both 3-dimensional and two-dimensional multi-floor views shall be available. System features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the configuration of multiple time schedule profiles shall be available. A web based Graphical User Interface (GUI) application integral to the system will be used to develop a dynamic, real-time, point-and-click graphic of each floor plan with representation of all light luminaire, wall stations, sensors, switches, etc. A central system server will be provided to support system data base and enterprise control management.

1. System Requirements:

a. Software must be able to run on a Windows operating system (Windows 10) and also on Apple Mac Intel PCs.
b. Must support all common browsers, i.e.,

1) Internet Explorer
2) Mozilla Firefox
3) Safari
4) Google Chrome

c. Must provide network connection/access to all network-enabled devices.

C. The GUI shall give the user the ability to temporarily override timeclock and zone parameters on a zone-by-zone basis for after-hours events.

D. All programming shall be provided by the lighting controls system manufacturer.

2.12 ENERGY MANAGEMENT SYSTEM (EMS) GATEWAY

A. System shall provide a BACnet MS/TP gateway as a downloadable software plug-in to its management software.

B. System shall be capable of communicating and receiving input from the owner’s EMS system.

C. BACnet MS/TP connection shall communicate information gathered by networked system to other energy management systems.

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 2021 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 lighting controls manufacturer shall provide eight hours of in-person instruction for the owner's personnel in proper maintenance, adjustment, and operation of the lighting controls and graphical user interface. The training shall be recorded and turned over to the owner for future education and training.

3.5 PROJECT CLOSEOUT DOCUMENTATION

A. Provide a factory published manual:

1. Warranty
2. Technical support contact

3. Electronic manual

END OF SECTION

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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.

E. Emergency Management System (EMS) Gateway

1. System shall provide a BACnet MS/TP gateway as a downloadable software plug-in to its management software.
2. System shall be capable of communicating and receiving input from the owner's EMS system.
3. BACnet MS/TP connection shall communicate information gathered by networked system to other energy management systems.

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. This section specifies the basic requirements for communications installations as indicated or required and includes requirements common to more than one specification section of this division (such as related documents, related sections, definitions, governing requirements, contractor requirements, warranty requirements, submittal requirements/procedures, and project closeout requirements/procedures, as well as other requirements). This section may expand upon and/or supplement the requirements specified in Division 01.

B. Examine the contract documents in their entirety (including drawings and specification sections in the other divisions) for requirements or work which may affect work under this section, regardless of whether such requirements or work are specifically indicated in this section.

C. Related Sections:

1. Section 00 00 00 – Procurement and Contracting Requirements
2. Section 01 00 00 – General Requirements
3. Section 07 84 00 – Penetration Firestopping
4. Section 27 05 26 – Grounding and Bonding for Communication Systems
5. Section 27 05 28 – Pathways for Communication Systems
6. Section 27 10 10 – Voice and Data Cabling Distribution System
7. Section 27 20 00 – Data Communications Equipment
8. Section 27 30 00 – Voice Communications Equipment

1.2 DEFINITIONS

A. ANSI – American Northern Standards Institute

B. AWG – American Wire Gauge

C. BICSI – Building Industry Consulting Service International

D. BCT – Bonding Conductor for Telecommunications

E. EIA – Electronics Industry Alliance

F. ETL – Intertek Certification Services

G. IEC – International Electrotechnical Commission

H. IEEE – Institute of Electrical and Electronic Engineers

I. IDC – Insulation displacement contact

J. ISO – International Standards Organization

K. NECA – National Electrical Contractors Association

L. NFPA – National Fire Protection Agency

M. NRTL – Nationally Recognized Testing Laboratory

N. TIA – Telecommunications Industry Association

O. UL – Underwriters Laboratory

P. Provide: Furnish, install, terminate, label, test and certify a complete operating cabling system.

Q. Contract Documents (CD): Design drawings, specifications, sketches and schedules provided by the Engineer as they directly relate to this scope of work and this project.

R. Point–of–Entry (POE): Unmarked Manholes/Vaults at property line for franchise utility cabling.

S. NET–POP Rooms/MPOE (Main Point of Entry): The area where the outside plant media/carrier services appear in the facility. The NET–POP contains equipment used by owner or carrier to hand–off/transition cable from outside plant into inside plant type.

T. Network Center/Main Distribution Frame (MDF) Areas: This technology space houses Layer 2/3 network switching gear and other main network distribution equipment and acts as the mid–connection point between the Core/Network and the TR/IDF/access zones for all connections.

U. Telecommunications Room (TR)/Intermediate Distribution Frame (IDF): is the location for the termination of backbone cables and for termination of horizontal cables, and for the interconnection of each. The space also hosts access–layer switches and user network connections within each floor.

V. Active Equipment: electronic equipment used to develop various WAN, LAN, and voice services, e.g., digital multiplexers, RS–232 controllers, Ethernet hubs, switches, routers, PBX, etc.

W. Building Backbone: cabling system consisting of media and termination hardware interconnecting MDFs to IDFs.

X. Horizontal: cabling system consisting of media and termination hardware interconnecting the Telecommunication Outlets (TOs) and the TRs.

Y. Bonding: permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on it.

Z. Basket Cable Tray: A cable support and management system fabricated of continuous, rigid, welded steel wire mesh and available in many sizes with attachment hardware suiting multiple installation methods

AA. Cable Tray: vertical or horizontal open supports, usually made of aluminum or steel, which are fastened to the building structure. Cables are laid in and fastened to the trays.

BB. Cabinet: free standing, floor–mounted or wall–mounted modular enclosure designed to house and protect rack–mounted electronic equipment and passive terminations.

CC. Channel: The end–to–end transmission path between two points at which application specific equipment is connected; encompasses all the elements of the horizontal cabling link, plus the equipment cords in the telecommunications spaces and work area.

DD. Cross–Connect: equipment used to terminate and tie together communications circuits.

EE. Cross–Connect Jumper: a cluster of twisted–pair conductors without connectors used to establish a circuit by linking two cross–connect termination points.

FF. Grounding: a conducting connection to earth, or to some conducting body that serves in place of earth.

GG. Jack: receptacle used in conjunction with a plug to make electrical contact between communications circuits, e.g., eight–position/eight–contact modular jacks.

HH. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

II. LAN: Local area network.

JJ. Link: Horizontal cabling link encompassing all components of the horizontal cabling (TO, patch panels, blocks, jumpers and patch cords that join them in the horizontal cross–connect). It is distinguished from a channel because it does not include the equipment cables/cords at the telecom spaces or work area.

KK. Media: twisted–pair, and fiber optic cable or cables used to provide signal transmission paths.

LL. Mounting Frame: rectangular steel framework, which can be equipment rack or wall mounted to support wiring blocks, patch panels, and other communications equipment.

MM. Outside Plant (OSP): generally, any and all portions of the cable system that runs outside of an environmentally enclosed structure and/or building with each end terminated at different buildings. This specifically includes inter–building cables, conduits, manholes, hand–holes, and innerduct.

NN. UTP: Unshielded Twisted Pair.

OO. FO: Fiber Optic

PP. Passive Equipment: non–electronic hardware and apparatus, e.g., equipment racks, cable trays, electrical protection, patch panels, wiring blocks, fiber optic shelves, etc.

QQ. Patch Cords: a length of wire or fiber cable with connectors on one or both ends used to join communications circuits at a cross–connect.

RR. Patch Panel: system of terminal blocks or connectors used with patch cords that facilitate administration of cross–connect fields.

SS. Pathway: facility for the placement of communications cable. A pathway facility can be composed of several components including conduit, wireway, cable tray, surface raceway, under floor systems, overhead systems, raised floor, ceiling support wires, etc.

TT. Protectors: electrical protection devices used to limit foreign voltages on metallic communications circuits.

UU. Raceway: an enclosed channel designed expressly for holding wires or cables; may be of metal or insulating material. The term includes conduit, tubing, wire ways, under floor raceways, overhead raceways and surface raceways; does not include cable tray.

VV. Racks: An open, freestanding, floor–mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.

WW. Riser Backbone: The Riser Backbone subsystem links the main cross connect (MDF) in the equipment room to the distribution rooms (TRs).

XX. Structured Cabling System (SCS): A SCS is defined as all required cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, telecommunication outlets, work area cords, UTP and fiber optic cable installed and configured to provide computer data and voice connectivity from each data or voice device to the network file server or voice network/switch designated as the service point of the local area network.

YY. Telecommunication Outlet (TO): Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.

ZZ. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

AAA. Work Area Subsystem: The connection between the telecommunications outlet and the station equipment in the work area is provided by the Work Area Subsystem. It consists of cords, adapters, and other transmission electronics.

BBB. Wireless Access Point (WAP): Telecom outlet designated for use with wireless network devices. Such outlet shall be mounted above ceiling.

CCC. Contractor – The successful bidder engaged to provide the work of this specification.

1.3 REFERENCES

A. Most recent editions and addenda of the following documents:

B. ANSI/TIA 568 series, most recent revisions, addenda and systems bulletins. All applicable

C. ANSI/TIA–569 Telecommunications Pathways and Spaces, most recent revision including all relevant addenda and systems bulletins

D. ANSI/TIA–606 Administration Standard for Telecommunications Infrastructure, most recent revision including all addenda and systems bulletins

E. ANSI/TIA–607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, most recent revision including all addenda and systems bulletins

F. ANSI/TIA–862 Structured Cabling Infrastructure Standard for Intelligent Building Systems, most recent revision including all addenda and systems bulletins

G. ANSI/TIA–4966 Telecommunications Infrastructure Standard for Educational Facilities, most recent revision including all addenda and systems bulletins

H. TIA–TSB–162 Telecommunications Cabling Guidelines for Wireless Access Points, most recent revision including all addenda and systems bulletins

I. Telecommunications Distribution Methods Manual, most recent edition

J. Information Transport Systems Installation Methods Manual (ITSIMM), most recent edition

K. National Electric Codes (NEC) – all applicable

L. OSHA Standards and Regulations – all applicable

M. Local Codes and Standards – all applicable

N. UL444 – Standard for Safety of Communications Cable

O. UL 1666 – Standard for Safety of Flame Propagation Height

P. Local Authority Having Jurisdiction (AHJ)

Q. Anywhere cabling standards conflict with one another or with electrical or safety codes, Contractor shall defer to the NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.

R. Any violations of applicable standards or codes committed by the Contractor shall be remedied at the Contractor's expense.

1.4 SUBMITTALS

A. Provide submittals in accordance with other related sections included in this project.

B. Action Submittals:

1. Shop Drawings – RCDD stamped

a. Submit Overall floor and site plans showing the locations of devices and cable routing paths with cable types and quantity called out.

b. Submit Shop drawings for the entire structured cabling system and grounding and bonding system, identifying such items as PBB, SBB, TBB, rack fills, cabling pathways and pathway fills, ladder and other cable raceways, coordination with other trades, etc.

2. Rack Elevation drawings
3. Catalog cut sheets and data sheets containing physical and dimensional information, performance data, electrical characteristics, materials used in fabrication, and material finish. Clearly indicate on each sheet what is being submitted on
4. Qualification Data: Submit at least three references for telecommunications cabling jobs already completed, involving both fiber optics and twisted pair cabling, similar in scope to the project described herein. Include, for each customer reference, the following information: Company name, address, phone number, name and email address of contact and type of job completed.

C. Provide all applicable portions of the following information for sections listed in paragraph 1.1 above, in addition to the standard requirements, within 7 days after receiving each reel and/or box of cable:

1. Manufacturer's product test data for fiber optic cable components.
2. Visually inspect Category 6 and 6A UTP. Materials cannot be used before results have been submitted to CM and approved by the Owner or its representative.
3. On–reel OTDR testing of all fiber.

D. Provide all applicable portions of the following completed test documentation for sections listed in paragraph 1.1 above, in addition to the standard requirements, within 10 days after completion of the tests for each cable channel or link:

1. Test reports shall be submitted in the following manner:

a. To the Owner: One copy on eight and one–half inch by eleven papers providing for quality reproducible printing, and electronic copy in MS Excel format.
b. Submit test report documentation through CM for review by the Engineer for specification conformance and one copy in electronic format.

2. Twisted–pair field test documentation.

1.5 CLOSEOUT DOCUMENTS

A. Final close out documents including, but not limited to, all horizontal and backbone cable link/channel test results (in both native tester format and Adobe pdf format), Contractor and manufacturer warranty documents/certificates, As-Built drawings, product cut sheets, material submittals, etc.

1. All documentation shall be provided in a structured digital format, unless otherwise noted.
2. As-Built drawings.

a. As-Built drawings shall at minimum depict architectural room names/numbers, basic furniture, cable outlet locations/work area outlet types/cable performance/identification, MDF/IDF highlighted locations MDF/IDF serving zone boundaries, main cable pathway routing and pathway types, and backbone riser counts/types of MDF/IDF locations indicated on such drawing sheet.
b. A full-size laminated drawing (e.g., C/D/E1/E-size) shall be hung in each MDF/IDF. Each MDF/IDF drawing or drawings shall depict the complete serving zone area which the MDF/IDF serves.

1.6 QUALITY ASSURANCE

A. Warranty

1. Contractor shall provide a 2–year Installation Warranty on all copper and fiber links and/or channels.

a. The communications Contractor will correct any problems and malfunctions that are warranty–related issues without charge for the entire warranty period.

B. Testing and Inspection of Communications Equipment

1. Provide tests specified below, when applicable, and as indicated under individual items of material, equipment, and work specified in this Specification.

a. Furnish all test equipment and instruments required for the tests.
b. Responsible, qualified employees of the contractor in the presence of the Owner or an authorized representative shall perform the cable testing.
c. All individuals involved in the testing phase of the project shall not have been involved in the installation phase nor shall have immediate knowledge of the installation task.

2. End-to-end the performance of all parts and channels will be tested.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather–tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.8 RESPONSIBILITIES AND COORDINATION

A. The contractor shall provide all materials, qualified labor and services required to ensure a complete and operational system, installed in accordance with the intent of the Contract Documents.

B. The contractor shall furnish and install all incidental items not actually shown or specified, but which are required by best practices to provide complete functional systems.

C. The contractor shall coordinate the details of facility equipment and construction for all specification divisions, which affect the work covered under this Division.

D. The contractor shall coordinate all activities with the overall construction schedule.

E. The contractor shall ensure materials, in excess of, those required to complete the project are kept in their original condition and packaging for restocking.

PART 2 - EXECUTION

2.1 WORKMANSHIP

A. Manufactured products, materials, equipment, and components shall be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer’s specifications and printed instructions.

B. The installation of all system components shall be carried out under the direction of qualified personnel. Appearance shall be considered as important as mechanical and electrical efficiency. Workmanship shall meet or exceed industry standards.

2.2 INTENT OF DRAWINGS

A. The technology drawings show only general locations of equipment, devices, raceways, cable trays, boxes, etc., unless specifically dimensioned.

B. The contractor shall be responsible for the proper placement and routing of equipment, cable, raceways, cable runway, and related components, according to the Contract Documents and subject to prior review by the Owner and structured cabling engineer.

2.3 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI/TIA–607 and the National Electrical Code.

2.4 FIRESTOPPING

A. Comply with requirements in the National Building Code and the National Electrical Code.

B. Comply with Section 07 84 00 “Penetration Firestopping”.

2.5 LAYOUT AND TOLERANCES

A. Follow as closely as practicable the schematic design shown on the drawings. Make all necessary measurements in the field to verify exact locations and ensure precise location and fit of specified items in accordance with the drawings. Make no substantial alterations without prior approval of the Owner and the Engineer.

2.6 CABLE TERMINATION AND TEST PLANS

A. General

1. Provide proof of testing technician(s) certification for operation of the specific units of test equipment, which are proposed for use.
2. The contractor shall obtain CM approval for each termination and test plan prior to execution of the work.
3. This Section covers work necessary to furnish communications system testing, including the following:
    a. Outside Plant (OSP) Cabling Infrastructure (Campus LAN/WAN extension)
    b. Back–Bone Cabling Infrastructure
    c. Horizontal Cabling Systems
4. Inspection Requirements:
    a. As part of any performance test, inspect cable, material, and equipment for physical damage, continuity, and proper connection.
    b. Verify identification and labeling at required locations for visibility, condition, legibility, and accuracy.
5. Test Report Requirements – Each test report shall include the following sections:
    a. Scope of testing
    b. List of equipment used in the test with a photocopy of the factory calibration certificate.
    c. List of technicians performing the tests identified in the scope of testing
    d. Summary of test results: Hardcopy and electronic copies of the summary forms are to be delivered at conclusion of the project before final payment will be made.
    e. Individual test data sheets: The individual test data sheets shall be developed and completed by the contractor. Formatted output from cable scanners is typically acceptable provided they contain all of the test parameters including graphs of the information required by this Section.

B. Cable Termination Plans

1. Submit detailed termination plans for both fiber optic and twisted pair cables, which describe how each system component will be installed and terminated.

C. Cable Test Plans

1. Submit detailed test plans for both fiber optic and twisted–pair cable channels which include at least the following information:

a. Describe the tests to be performed.
b. Explain when and how each system component will be tested.
c. List the test equipment to be used.
d. Itemize how theoretical loss budgets and test parameters will be calculated and listed.
e. Provide an example of the test reporting documentation for each type of test, which provides a written verification of the results, as required in paragraph 2 below.

2. Provide testing documentation which includes:

a. Dates and times of test
b. Personnel performing tests
c. Initial test results
d. Description of discrepancies found or failure, if any
e. Corrective action, if any
f. Date and person performing corrections
g. Retest results, if required
h. Include space for Owner's sign–off
i. Copy of test equipment calibration certificates
j. Intrabuilding (Vertical and Horizontal Subsystem) fiber optic segment post–installation test plan

3. Twisted–Pair Cable Tests: Testing shall be performed using a minimum level IIIe tester, approved by the engineer.
4. Twisted–Pair Test Plans: Provide separate post–installation test schemes for the following activities:

a. Backbone Subsystem twisted–pair segment test plan.
b. Horizontal Subsystem twisted–pair segment test plan.

5. Fiber–Optic Cable Tests: Testing shall be performed using a level IIIe tester, with approved test–heads approved by the engineer.
6. Fiber–Optic Test Plans: Provide separate post–installation test schemes for the following activities:

a. Backbone subsystem fiber–optic segment test plan.
b. Horizontal subsystem fiber–optic segment test plan.

2.7 TESTING AND INSPECTION OF COMMUNICATIONS EQUIPMENT

A. Provide tests specified below, when applicable, and as indicated under individual items of material, equipment, and work specified in this Specification.

1. Furnish all test equipment and instruments required for the tests.
2. Responsible, qualified employees of the contractor in the presence of the Owner or an authorized representative shall perform the cable testing.
3. All individuals involved in the testing phase of the project shall not have been involved in the installation phase nor shall have immediate knowledge of the installation task.

2.8 FINAL TEST AND ADJUST

A. The contractor shall be responsible for post–installation performance testing of all cabling systems specified elsewhere in this Section of the Contract Documents.

1. Testing procedures shall permit recording the length of each link, theoretical loss budget, and tested parameters for each pair and fiber, including space for sign–off by CM and Owner.
2. Any cable links or fiber strands, which fail to meet performance test criteria, shall be re–terminated, re–connectorized, or replaced by the contractor free of charge.
3. Submit final field test documentation in list form, including the CM signature for Owner's approval.

B. Unshielded Twisted–Pair Cable System Testing

1. Permanent Link Test Configuration: Perform metered tests on each multi–pair twisted–pair and/or four–pair UTP cable through the wiring block, patch panel, at each end of the cable section and/or

telecommunication outlet (T.O.). The permanent link test shall be undertaken as described in ANSI/TIA–568–C.2–1.

2. Performance Testing:

   a. Horizontal Cable System:

      1) Use a minimum Level IIIe field test instruments capable of the following swept/stepped frequency voltage measurements in accordance with the performance parameters required by ANSI/TIA–568–C.2–1
      2) Test each horizontal link to verify/determine, wire map, length, attenuation, skew, and near–end–cross–talk (NEXT) as described in ANSI/TIA–568–C.2–1.

   b. Test Reports: Include field test results for each cable including cable link length in accordance with ANSI/TIA–568–C.2–1.
   c. The test summary shall include:

      1) Cable Identification as it appears on cable schedule.
      2) Cable identification as it appears on the individual test reports.
      3) Cable identification as it is labeled in accordance to the Specifications.
      4) Pass/Fail Status.
      5) All test parameters shall appear on each test document including graphics and indicating each test parameter result.
      6) The individual test data sheet shall include the automated print out produced by the cable scanning equipment.

2.9 CONSTRUCTION REVIEW

A. The Engineer and Owner will review and observe installation work to ensure compliance by the contractor with requirements of the Contract Documents.

B. The contractor shall inspect, and test completed communications installations to demonstrate specified performance levels including the following:

   1. Furnish all instruments and personnel required for the inspections and tests.
   2. Perform tests in the presence of the Engineer and Owner.
   3. Demonstrate that the system components operate in accordance with the Contract Documents.

C. Review, observation, assistance, and actions by the Engineer and Owner shall not be construed as undertaking supervisory control of the work or of methods and means employed by the contractor. The Engineer and Owner review and observation activities shall not relieve the contractor from the responsibilities of these Contract Documents.

D. The fact that the Engineer and Owner does not make early discovery of faulty or omitted work shall not bar the Owner from subsequently rejecting this work and withholding payment until the contractor makes the necessary corrections.

E. Regardless of when discovery and rejection are made, and regardless of when the contractor is ordered to correct such work, the contractor shall have no claim against the Engineer or Owner for an increase in the Subcontract price, or for any payment on account of increased cost, damage, or loss.

2.10 PROJECT RECORD DOCUMENTS

A. Provide detailed project record documentation for sections listed in paragraph 1.1.C above, in addition to the standard requirements, within 30 days after completion of the work.

B. Maintain separate sets of redlined record drawings for the communications work, which show the exact placement, and identification of as–built system components. These are subject to weekly review by the CM, Owner, or its representative.

C. Provide communication room record drawings which indicate exact placement for all components; e.g., conduit, wireway, cable tray, backboards, equipment cabinets, equipment racks, and cross–connect equipment, etc.

D. Provide communication wiring and cabling record drawings and schedules which indicate exact placement, routing, and connection details for all components, e.g., twisted–pair cables, splices, cable cross–connect termination locations, enclosures, telecommunications outlets, and cross–connect jumpers, patch cords, etc.

E. Provide network schematics when appropriate.

F. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

G. Cabling Administration Drawings: Show building floor plans with cabling administration–point labeling. Identify labeling convention and show labels for TR/IDFs, backbone pathways and cables, entrance pathways and cables.

2.11 CONTRACTOR REQUIREMENTS

A. General

1. Contractor shall have at least 5 years documented experience installing and testing structured cabling systems of similar type and size.
2. Contractor shall employ at least one BICSI Registered Communication Distribution Designer (RCDD) to sign–off on all designs offered, including stamping the design with their current BICSI/RCDD stamp.
3. Contractor shall have all necessary permits, licenses, and inspections required for the performance of data, voice, and fiber optic cable installations.
4. The Telecommunications contractor shall provide a Project Manager to serve as the single point of contact to manage the installation, speak for the contractor and provide the following functions:
    a. Initiate and coordinate tasks with the General Contractor and others as specified by the project schedule.
    b. Provide day–to–day direction and–site supervision of Contractor personnel.
    c. Ensure conformance with all contract and warranty provisions.
    d. Acknowledge and remediate findings of the General Contractor’s weekly site project meetings.
    e. This individual will remain Project Manager for the duration of the project.

B. References and Response Times

1. Communication Contractor shall provide with bid, a list of four (4) reference accounts where similar Data, Voice, Fiber Optic Cable, and related equipment installation work was performed within the last year (twelve–month period).

C. Other Contractor Responsibilities

1. Confirmation of Pathway and Cable Manager sizing:
    a. Wherever cabling pathways or managers are installed, it is the Contractor’s responsibility to confirm pathway or manager sizing to represent no more than 25% fill upon installation according to manufacturer’s fill tables.
    b. Pathways deemed overfilled upon installation will not be accepted and shall be remedied at Contractor expense.
2. Contractor is responsible for the removal and disposal of all installation and construction debris created in the process of the job.

3. All work areas will be cleaned at the conclusion of the project jobsite and no tools or materials shall be left in a manner as to pose a safety hazard.

END OF SECTION

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SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Grounding and bonding involves establishing a low-impedance path to the earth for electrical energy dissipation, while bonding involves connecting all metal objects to the system together to ensure they have the same electrical potential.

B. Proper grounding and bonding practices minimize the risk of damage to equipment and information loss, as well as to protect personnel against electrical hazards/shock.

C. This section includes minimum requirements for telecommunications grounding and bonding products, design, and installation.

D. The telecommunications grounding system as described herein, shall be dedicated for telecommunications use only.

E. The Drawings indicate needs for the project (e.g., devices, device locations, quantities, connectivity, etc.) and the specifications describe the components required and how to install such components. Not all sections of this specification may be relevant to all projects.

1.2 WORK INCLUDES

A. Provide telecommunications grounding backbone system from the MDF/IDF busbar/s to earth ground.

B. Provide all labor, materials, and equipment for the complete installation of work called out in this section.

C. Work provided by the Division 26 Electrical Contractor, for communications, as specified in this section and as indicated on T-series drawings shall include:

1. All telecommunications busbars
2. The conductor between the main electrical service ground and main telecommunications busbar, conductors between busbars, conductors between busbar/s and building steel, conductors between busbars and local electrical panels.
3. Any required conductor pathway (e.g., conduit and associated grounding as required)
4. Associated connections (low emission exothermic welding, lugs, taps, etc.) to complete the telecommunications grounding backbone system.
5. Labeling and testing

D. Work to be specified in other sections:

1. The bonding of telecommunications infrastructure such as telecommunications information cabling conduit, cable tray, basket tray, cable runway, equipment racks/cabinets, cable sheaths/armor/strength-members, surge protective devices, electrostatic discharge flooring, etc. to the telecommunication busbar/s.

1.3 SYSTEM REQUIREMENTS

A. Provide a low impedance path from communications grounding busbars to earth. This system shall be used for communications infrastructure bonding such as, but not limited to, pathways, enclosures, racks, cabinets, cable armor/sheaths/strength-members, entrance protectors, and equipment.

B. The communications grounding system's earth ground shall originate from the building's main electrical service grounding electrode system. Resistance to earth ground, from main electrical service ground shall be equal to or less than 5 ohms.

C. The resistance between any communications grounding busbar and the main electrical service ground shall be 100 milliohms (max).

D. The communications ground system shall be independent from all power grounding except for the connection to the building's electrical service main grounding electrode system.

E. Power grounding and/or bonding shall not be allowed to interfere or provide any back feed or be a conductor to the separate communications ground system source or to any communications bonded materials or equipment.

F. The requirements as provided in this document and drawing package are to be adhered to unless revised by the Owner in writing.

1.4 RELATED SECTIONS

A. Related work specified in other sections

1. Section 26 00 00 - Electrical (including related sub-sections)
2. Section 27 05 00 – Common Work Results for Communications

1.5 REFERENCES

A. Codes and Standards

1. ANSI J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
2. Refer to Section 27 05 00 for additional codes and standards

B. Strictly adhere to all BICSI, TIA, and EIA documentation for industry standard recommendations and practices when installing telecommunications grounding systems.

C. Specific reference to specifications, codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract.

1.6 QUALITY ASSURANCE

A. Contractor Qualifications

1. Contractor shall be regularly engaged in the installation of grounding and bonding systems and have a minimum of five (5) years installation experience with systems similar to those required for this project.

2. Contractor shall provide references to include client names, phone numbers, and a summary of project details. These references will be checked and references will be asked questions relative to the performance of the Contractor.
3. Contractor shall provide verification documentation that all installation personnel have been properly trained to install the products described in this section.
4. Contractor shall own all tooling and equipment required for system installation such as, but not limited to lug/CTAP/HTAP irreversible crimping, exothermic welding, and test equipment.
5. The Contractor shall dedicate a full-time project manager with a minimum of ten (10) years field experience in installation of the specified system. Project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the Owner.
6. The Contractor shall employ an Electrical Engineer (PE), Master Electrician, or BICSI certified RCDD 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 guidance as required.

B. System installation shall be performed in a neat and workmanlike manner.

C. All 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.

D. Where requirements between governing codes and regulations vary, the more restrictive provision shall apply.

E. Nothing in the contract documents shall grant authority or permission to disregard or violate any legal requirement.

1.7 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Provide all submittal requirements under this section in a single submittal package.

D. Provide product data for each type of product:

1. Busbar manufacturer, sizes, and part numbers
2. Conductor material, sizes, insulation type
3. Lug, CTAP, and HTAP manufacturer and part numbers
4. CTAP and HTAP insulator manufacturer and part numbers
5. Antioxidant joint compound specifications

E. Provide proposed testing procedures.

F. Provide Shop Drawings, in pdf electronic format, indicating telecommunication busbar locations and labeling identification, conductor routing pathways, sizes, and extremity label identification, and the main electrical service panel ground location.

G. All product data submittals shall indicate all required information in order to support compliance with the specifications.

1.8 PERMITS

A. The Contractor shall secure and pay for all required permits and fees required for the execution of this work. Work shall not commence until all permit applications have been 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.

B. As/If required for the project, work shall be scheduled as to not interfere with day-to-day operations of the facility.

C. The Contractor will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in containers or reels in manufacturer/factory packaging. Store materials in a clean and dry space and protect products from damage. Handle materials in accordance with manufacturer's recommendations to avoid damage.

B. Material storage space on project site may be limited. Contractor shall coordinate delivery and arrange storage of materials and equipment with the Owner. Contractor may need to allow for material storage in a Contractor provided storage container.

C. Components and/or equipment sensitive to damage in a harsh environment, such as electronics, shall be stored off-site and delivered as needed.

D. Contractor shall be responsible for on-site security of materials, tools, and test equipment.

E. Contractor shall provide protective coverings, as required during construction, to prevent damage to installed components.

F. At no expense to the Owner, the Contractor shall replace components/materials damaged during storage, handling, or installation throughout the construction duration.

1.11 PROJECT CONDITIONS

A. Verify all site conditions applicable to this work. Notify the Architect of discrepancies, conflicts, or omissions in writing promptly upon discovery.

B. The drawings diagrammatically show components fitting the available space without interference. If conditions exist making it impossible to install components as indicated, recommend possible solution/s and/or submit drawings indicating a solution to the Architect for approval.

1.12 CONFLICTS

A. This installation shall be made in strict accordance with the specifications, drawings, all applicable codes, and practices referenced in publications and standards. In case of conflicts between the aforementioned, notify the Owner in writing prior to commencement of affected work.

1.13 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements.

B. Provide Record Drawings, in pdf electronic format, indicating telecommunication busbar locations and labeling identification, conductor routing pathways, sizes, and extremity label identification, and the main electrical service panel ground location.

C. Provide test results as requested.

1. Two-point resistance test for each busbar
2. Ground loop current for each installed conductor.

D. Provide recommended maintenance of the telecommunications grounding system.

1.14 WARRANTY

A. Contractor shall warrant all materials and labor 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. Contractor shall repair or replace defects occurring in labor or product within the warranty period without charge.

B. Any materials/components replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

1.15 DEFINITIONS AND TERMS

A. Trade names for communications components and sub-systems are often abbreviated. The following acronyms and/or abbreviations may be referenced within this section.

1. ANSI American National Standards Institute
2. AWG American Wire Gauge
3. BBC Bonding Backbone Conductor
4. BICSI Building Industry Consulting Services International
5. EF Entrance Facility
6. EIAElectronic Industries Alliance
7. IEEE Institute of Electrical and Electronics Engineers
8. IDFIntermediate Distribution Frame
9. MDF Main Distribution Frame
10. NEC National Electric Code
11. NEMA National Electric Manufacturers Association
12. NFPA National Fire Protection Association
13. NRTL Nationally Recognized Testing Laboratory
14. PBB Primary Busbar
15. PE Professional Engineer
16. RBC Rack Bonding Conductors

17. RCDD Registered Communications Distribution Designer
18. SBB Secondary Busbar
19. TDMM Telecommunications Distribution Methods Manual
20. TEBC Telecommunications Equipment Bonding Conductor
21. TBB Telecommunications Bonding Backbone
22. TBC Telecommunications Bonding Conductor
23. TIA Telecommunications Industry Association
24. UL Underwriters Laboratories

PART 2 - PRODUCTS

2.1 GENERAL

A. All references to manufacturers, model numbers, and other pertinent information herein are intended to establish standards of performance and quality of construction.

1. When an approved manufacturer is noted with “no exceptions”, the required component shall be the manufacturer, type, series, and/or part number indicated. Alternates will not be accepted.
2. When several manufactures are noted as acceptable and a specific manufacturer, type, series, part number, and/or specifications is indicated, this is to be used as the basis of design. The Contractor may substitute a component from another approved manufacturer that meets the specifications described.
3. “Approved alternates” must be approved, prior to bid, and if accepted by the Owner, will be issued to all Bidders, in writing, in the form of an addendum.

B. The products specified in this document do not necessarily constitute the exhaustive list of products required to complete the project. The Contractor is responsible for providing all required parts and materials needed to deliver a complete and working system.

C. All products shall be recognized by a NRTL such as UL.

2.2 ACCEPTABLE MANUFACTURERS

A. Busbars

1. CPI (Chatsworth)
2. Harger
3. Panduit
4. Owner approved alternate

B. Conductor Cable

1. General Cable
2. Okonite
3. Houston Wire and Cable
4. Owner approved alternate

C. Lugs and Compression Taps

1. Harger
2. Burndy
3. Panduit
4. Owner approved alternate

D. Exothermic Connectors

1. nVent/Erico (Cadweld)
2. Hubbell (thermOweld)
3. Harger
4. Owner approved alternate

2.3 WALL MOUNTED BUSBARS

A. Telecommunications grounding busbars shall be constructed of hard-drawn rectangular solid copper, have pre-drilled hole patterns to accommodate two-hole lugs per the recommendation of ANSI/BICSI N3-20 and ANSI/TIA-607 standards, have 2-inch insulators and 2-inch stainless steel standoffs providing a total of 4-inches clearance behind the busbar and the wall.

1. Busbar thickness shall be 0.25-inch.
2. Busbar height shall be 2 or 4-inch.
3. Busbar length shall be 10, 12, or 20-inch.

B. Typical busbar sizing and application.

1. 0.25-inch x 4-inch x 20-inch (CPI 40153-020) for use as PBB in the MDF/EF
2. 0.25-inch x 4-inch x 12-inch (CPI 40153-012) for use as SBB/PBB in the IDF/MDF/EF
3. 0.25-inch x 2-inch x 12-inch (CPI 13622-012) for use as SBB in the IDF
4. 0.25-inch x 2-inch x 10-inch (CPI 13622-010) for use as SBB in the IDF

C. Refer to drawings for busbar mounting locations, mounting heights, and minimum sizes. Contractor shall size busbar height and length for current bonding conductor needs plus twenty-five percent (25%) growth.

2.4 CONDUCTOR CABLES

A. Comply with UL 486A-486B

B. Conductor material shall be copper.

C. All conductor cables shall be 600V, UL 83 insulated and shall have a green, or green with a yellow strip sheath. When green, or green with a yellow strip insulation is unavailable, black sheath may be utilized. When black sheath is utilized, a permanent green wrap of 2-inch axial length (min), such as shrink wrap, shall be installed at the cable termination extremities.

D. Ground conductors equal to, or larger than, # 6 AWG shall be stranded. Conductors smaller than # 6 AWG may be stranded or solid.

E. Refer to drawings for minimum conductor sizes and logical connectivity.

1. The TBC is the conductor between the PBB and earth ground source. For the telecommunications grounding system this earth ground source is typically the building's electrical service main grounding electrode system.
2. The TBB is the conductor between the PBB and the SBB. When multiple IDFs are stacked, there may be one (1) TBB from the PBB up through stacked IDF rooms. Each IDF's SBB may be bonded to the TBB via a tap and an equivalent sized bonding conductor to the SBB.
3. In multi-story buildings with multiple MDF/IDFs per floor, there shall be a BBC installed between all PBB/SBBs on the top floor and, at a minimum, every third floor in between.

F. As applicable bond each PBB/SBB to:

1. Local building steel (e.g., local MDF/IDF column, overhead steel, etc.). Refer to drawings for conductor sizing. If not indicated on drawings, provide a # 2/0 AWG (min) conductor.

2. Local MDF/IDF electrical panel ground bar. Refer to drawings for conductor sizing. If not indicated on drawings, provide a # 6 AWG (min) conductor.

2.5 LUGS AND COMPRESSION TAPS

A. Lugs and taps shall be listed by a NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and/or other components to which they are attached to.

B. All lugs shall be a 2-hole design with hole spacing matching the pre-drilled busbar hole spacing.

1. Irreversible crimp barrel lugs shall be made from electroplated tinned copper, have long barrel to allow for double compression crimps and have an inspection window to visibly confirm conductor insertion depth.
2. Exothermic welded lugs shall be manufactured from cast silicon bronze and have a long barrel.

C. Exothermic welds shall meet IEEE Standard 837 and is used for copper to copper, copper to steel, and copper to cast iron for grounding and cathodic applications. Weld metal shall contain copper oxide, aluminum and not less than three percent tin as the wetting agent

D. Exothermic welding kits, of types recommended by the component manufacturer, shall be used for each exothermic welded connection.

E. Compression taps shall be HTAP or CTAP design, manufactured form electroplated tinned copper alloy material, be of irreversible crimp and compress design to fully bond to the conductors when compressed. Each tap shall be finished with an insulated cover.

F. All lugs shall be secured to busbars via stainless steel hardware (i.e., bolts, washers, nuts) and properly torqued.

2.6 LABELING

A. Provide permanent, machine-generated labeling on busbars and conductor sheath extremities.

B. Each PBB/SBB shall be labeled with a black on white plastic engraved label.

1. Label shall be readable from a floor standing position.
2. Label shall state MDF/IDF room identifier and busbar type/purpose (e.g. MDF Communications PBB, IDF-1A Communications SBB).
3. Additional labeling shall be provided at each PBB/SBB stating “COMMUNICATIONS GROUND BAR, DO NOT REMOVE ANY CABLE/LUGS WITHOUT APPROVAL FROM THE IT DEPARTMENT”.

C. Each conductor cable sheath extremity (near the lug/tap) shall be labeled with an appropriately sized machine-generated self-laminating cable label.

1. Labels shall be oriented to be readable from a floor standing position.
2. At minimum, label shall indicate conductor function name and “far-end” location (e.g., TBC to Electric Room 101, TBB to IDF-1A, BBC to IDF-3B).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the main electrical service grounding electrode system for compliance with requirements for maximum ground resistance or other conditions which could affect the performance of the communications grounding system.

1. Maximum resistance between the electrical service main grounding busbar and earth ground shall be five ohms. If value exceeds this alert Owner for resolution.

3.2 PREPARATION

A. As required for exothermic welding process, coordinate with the building services personnel, in occupied spaces, to prevent the smoke from potentially setting off smoke/fire alarms.

B. All conductor, lug, tap mating surfaces shall be cleaned of debris, oxidation, moisture, oils, paint, etc. before the connection is made.

C. Aluminum-to-copper antioxidant joint compound should be available after cleaning to be used on copper-to-aluminum joints/bonds.

D. Copper-to-copper antioxidant joint compound should be available after cleaning to be used on copper-to-copper joints/bonds

3.3 GENERAL

A. Bonding should be accomplished such that the bonding system is integrated and compliant with NEC codes.

B. Securely mount busbars plumb and level at locations and elevations indicated on drawings.

C. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in a ferrous metallic conduit that exceeds 3-feet in length, the conductors shall be bonded to each end of the conduit using a grounding bushing and # 6 AWG conductor (min).

D. Conductors shall be installed from point-to-point without splices.

E. Conductor cables shall be supported at intervals not to exceed 36-inches.

F. Route bonding conductor/s the shortest distance between bonding contact points.

G. Grounding and bonding conductors shall be placed outside of cable tray which contains communications cabling. There shall be a minimum of 2-inches of separation between the grounding and bonding conductor/s and communications cabling except where they enter a cabinet or enclosure.

H. Bonding conductors shall be routed with minimum bends or changes in direction and should be made directly to the points being bonded. Bends shall be large sweeping bends in lieu of small radius bends.

1. The bend radius shall not be smaller than eight (8) times the conductor diameter. It is recommended to strive for a minimum bend radius of ten (10) times the conductor diameter.
2. No one bend shall be greater than ninety degrees.
3. There shall never be a “service loop” in a bonding link.

I. The conductor cables shall have a minimum amount of insulation removed at the ground lug/tap.

J. Bonding connections should be made by using irreversible compression lugs. However, for parts of the ground electrode system that are subject to corrosion, must carry high currents reliably, or for locations that require minimum maintenance, connections shall be made with low emission exothermic welding.

K. Thoroughly clean all joints of oxidation, paint, oils, etc. past the areas of contact. Apply an adequate amount of antioxidant joint compound, formulated for the metal surface types, to the joint. Complete joint via irreversible crimp (two required for lugs) or properly torqued mechanical fasteners (e.g., bolt, washer, lock washer, nut).

L. All lug/tap compression crimps shall be made with a crimping/compression tool and die specific to the lug/tap.

M. Stacking of lugs is not permitted under any circumstances.

N. Conductors shall be connected by connectors designed for that specific application to ensure adequate bonding.

3.4 VERIFICATION AND TESTING

A. Visually inspect all compression crimps prior to testing.

B. Verify tightness of bolted lug connections with a calibrated torque wrench according to manufacturer recommendations.

C. Confirm that all labels are installed and easily readable.

D. Test the bonding of connections of the system using an AC earth ground-resistance tester, taking two-point bonding measurements using the process recommended by the BICSI TDMM.

1. Conduct all test with the facility in operation
2. Measure the resistance between the PBB/SBB and the main electrical service earth grounding electrode.
3. The maximum acceptable value for this bonding resistance is 100 milliohms.

E. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale setting of 10 amps or less, capable of displaying current hundredths of amps (i.e. 0.01 amp) with an accuracy of plus/minus two percent.

1. Conduct all test with the facility in operation
2. Measure the current in every system conductor. The maximum acceptable current shall be less than 1 amp.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Communication pathways consist of the physical infrastructure required to support and protect communications cabling within a building or facility.

B. Well-designed pathways allow for improved cable performance and reliability by protecting cabling from deformation or crushing, physical protection, providing a fixed route separated from electromagnetic Interference/generating sources, internal cable heat buildup, etc. In addition, cabling system maintenance and troubleshooting benefits will be realized with a well-designed cabling pathway system.

C. This section includes minimum requirements for basket tray, conduit, floor sleeves, pull boxes, device boxes, non-continuous cable support such as j-hooks, innerduct, and firestopping.

D. The Drawings indicate needs for the project (e.g., devices, device locations, quantities, connectivity, etc.) and the specifications describe the components required and how to install such components. Not all sections of this specification may be relevant to all projects. For example if basket tray is not indicated on the drawings it is not a requirement for the project though the Contractor may choose to provide such if they deem it necessary.

1.2 WORK INCLUDES

A. Intra-building communications pathways and pathway support structure.

B. Proper bonding of communications pathway to an earth ground.

C. Provide all labor, materials, and equipment for the complete installation of work called out in this section.

D. Work provided by the Division 26 Electrical Contractor, for communications, as specified in this section and as indicated on T-series drawings shall include:

1. Device backboxes and associated technology conduit.
2. Floor devices (e.g., floor boxes, poke-throughs) and associated technology conduit.
3. Technology conduit/sleeves/fire stopping assemblies indicated on drawings.
4. Floor sleeves and/or floor firestopping devices/assemblies.
5. Exterior roof access pathway.
6. Fire stopping of annular space between provided conduits/sleeves and building assemblies (e.g., walls, floors, etc.).
7. Technology basket tray and associated firestopping systems through fire rated walls in which the tray intersects and continues on the opposite side.
8. Technology basket tray and associated framing or sleeves through non-fire-rated walls in which the tray intersects and continues on the opposite side.
9. Bonding to ground all provided pathway systems.

E. Work provided by the Division 27 Cabling Contractor as specified in this section and as required for a complete pathway system shall include:

1. Providing non-continuous cable supports and corresponding support hardware.
2. Wall sleeves (fire-rated when required and non-fire-rated).
3. Properly sealing conduit sleeves, and/or basket/cable tray framed out by others, for both fire-rated and non-fire-rated building assemblies.
4. Vertical cable supports.
5. Bonding to ground all provided pathway systems.

1.3 SYSTEM REQUIREMENTS

A. Provide a standards compliant communications cabling pathway system designed to support and protect cables.

B. Pathways shall include those between technology rooms used for backbone cabling and those used between the technology rooms and the user workstations and/or edge devices.

C. Basket tray shall be utilized as the main cable support system leaving the MDF/IDF rooms. As pathway approaches the MDF/IDF serving zone boundary, and for branch pathways, cable support shall transition to non-continuous cable supports, and finally to conduit to the device box.

D. Pathway over/through inaccessible ceiling areas (e.g., gypsum) and/or through open to structure ceiling areas shall be installed in conduit.

E. Pathway through hazardous areas, or areas where cabling is susceptible to damage, such as but not limited to, mechanical rooms, electrical rooms, dock areas, motorized vehicle areas, gymnasiums, warehouse areas up to overhead structure shall be installed in conduit.

F. All basket tray and conduit shall be bonded to an appropriate building ground.

G. All building assemblies penetrated by communications cabling (e.g., wall, floor), must be installed in a sleeve.

1. All fire-rated building assemblies (e.g., wall, floor), penetrated by communications pathway, shall be restored to the fire-rating of such building assembly by a UL approved firestopping system.
2. All non-fire-rated building assemblies penetrated by communications cabling must be restored to the intended purpose of such building assembly (e.g. smoke, sound, odor/gas, etc.) with an appropriate sealant.
3. A sleeve is not required where work area outlet cabling enters a non-fire-rated wall assembly, on one side only, and travels in the wall assembly void to a mud-ring/box eliminator outlet location.

H. All pathways shall be sized in accordance with BICSI and/or the NEC where pathway sizes are not specifically indicated on drawings. No conduit shall be less than 1-inch.

I. Pathway shall be sized for current, plus future, needs as follows:

1. The basket tray shall have twenty-five percent (25%) spare capacity. Note, basket tray is considered one hundred percent (100%) full at fifty percent (50%) cross-sectional area fill.
2. NCCS shall be sized for twenty-five percent (25%) spare capacity.

J. Conduits shall be sized as indicated on the drawings. Maximum fill for conduits shall be forty percent (40%).

K. The requirements as provided in this document and drawing package are to be adhered to unless revised by the Owner in writing.

1.4 RELATED SECTIONS

A. Related work specified in other sections.

1. Section 26 05 29 – Hangers and Supports for Electrical Systems
2. Section 26 05 32 – Raceways
3. Section 26 05 33 – Boxes for Electrical Systems
4. Section 27 05 00 – Common Work Results for Communications
5. Section 27 10 10 – Voice and Data Cabling Distribution System

1.5 REFERENCES

A. Codes and Standards

1. ANSI/TIA-569-E - Commercial Building Standards for Telecommunications Pathways and Spaces
2. Refer to Section 27 05 00 for additional codes and standards.

B. Strictly adhere to all BICSI, TIA, EIA, and NEC documentation for industry standard recommendations, practices, and codes when installing telecommunications pathway systems.

C. Specific reference to specifications, codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of the contract.

1.6 QUALITY ASSURANCE

A. Contractor Qualifications

1. The Contractor shall be regularly engaged in the installation of communications pathway systems and have a minimum of five (5) years' installation experience with systems similar to those required for this project.
2. The Contractor shall provide references to include client names, phone numbers, and a summary of project details. These references will be checked, and references will be asked questions relative to the performance of the Contractor.
3. The Contractor shall provide verification documentation that all installation personnel have been properly trained to install the products described in this section.
4. The Contractor shall own all tooling and equipment required for system installation such as, but not limited to one-shot conduit benders, coring machines, knockout punch kit, hammer drills, and powder actuated nail guns.
5. The Contractor shall dedicate a full-time project manager with a minimum of ten (10) years' field experience in installation of the specified system. A project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the Owner.
6. The Contractor shall employ an Electrical Engineer (PE), Master Electrician, or BICSI certified RCDD 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 guidance as required.

B. System installation shall be performed in a neat and workmanlike manner.

C. All 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.

D. Where requirements between governing codes and regulations vary, the more restrictive provision shall apply.

E. Nothing in the contract documents shall grant authority or permission to disregard or violate any legal requirement.

1.7 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Provide all submittal requirements under this section in a single submittal package.

D. Provide product data for each type of product:

1. Basket tray and accessories
2. Device box and accessories
3. Floor device and accessories
4. Conduit and fittings
5. Pull boxes and enclosures.
6. Firestopping devices/assemblies

E. Provide Shop Drawings, in pdf electronic format, indicating basket tray routing and sizes, device box locations, floor box locations and under slab/floor technology conduit routing, conduit routing, sizes, and pull box locations.

F. All product data submittals shall indicate all required information in order to support compliance with the specifications.

1.8 PERMITS

A. The Contractor shall secure and pay for all required permits and fees required for the execution of this work. Work shall not commence until all permit applications have been approved.

1.9 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by the Owner, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed.

B. As/If required for the project, work shall be scheduled so as not to interfere with day-to-day operations of the facility.

C. The Contractor will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in containers in manufacturer/factory packaging. Store materials in a clean and dry space and protect products from damage. Handle materials in accordance with manufacturer’s recommendations to avoid damage.

B. Material storage space on the project site may be limited. The Contractor shall coordinate delivery and arrange storage of materials and equipment with the Owner. Contractor may need to allow for material storage in a Contractor provided storage container.

C. Protect non-metallic conduit, innerduct, and fittings from UV sunlight damage. Protect metallic components from corrosion.

D. The Contractor shall be responsible for on-site security of materials, tools, and test equipment.

E. The Contractor shall provide protective coverings, as required during construction, to prevent damage to installed components.

F. At no expense to the Owner, the Contractor shall replace components/materials damaged during storage, handling, or installation throughout the construction duration.

1.11 PROJECT CONDITIONS

A. Verify all site conditions applicable to this work. Notify the Architect of discrepancies, conflicts, or omissions in writing promptly upon discovery.

B. The drawings diagrammatically show pathways in available space without interference. If conditions exist making it impossible to install pathways as indicated, recommend possible solution/s and/or submit drawings indicating a solution to the Architect for approval.

1.12 CONFLICTS

A. This installation shall be made in strict accordance with the specifications, drawings, all applicable codes, and practices referenced in publications and standards. In case of conflicts between the aforementioned, notify the Owner in writing prior to commencement of affected work.

1.13 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements.

B. Provide Record Drawings, in pdf electronic format, indicating basket tray routing and sizes, device box locations, floor box locations and under slab/floor technology conduit routing, conduit routing, sizes, and pull box locations.

1.14 WARRANTY

A. Contractor shall warrant all materials and labor 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. Contractor shall repair or replace defects occurring in labor or product within the warranty period without charge.

B. Any materials/components replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

1.15 DEFINITIONS AND TERMS

A. Trade names for communications components and sub-systems are often abbreviated. The following acronyms and/or abbreviations may be referenced within this section.

1.	ANSI	American National Standards Institute
2.	AWG	American Wire Gauge
3.	BICSI	Building Industry Consulting Services International
4.	EF	Entrance Facility
5.	EIA	Electronic Industries Alliance
6.	EMT	Electrical Metallic Conduit
7.	FMC	Flexible Metallic Conduit
8.	GRC	Galvanized Rigid Conduit
9.	IEEE	Institute of Electrical and Electronics Engineers
10.	IDF	Intermediate Distribution Frame
11.	IMC	Intermediate Metal Conduit
12.	LTC	Liquid-Tight Conduit
13.	MDF	Main Distribution Frame
14.	NCCS	Non-Continuous Cable Support
15.	NEC	National Electric Code
16.	NEMA	National Electric Manufacturers Association
17.	NFPA	National Fire Protection Association
18.	NRTL	Nationally Recognized Testing Laboratory
19.	PE	Professional Engineer
20.	RCDD	Registered Communications Distribution Designer
21.	RMC	Rigid Metallic Conduit
22.	TDMM	Telecommunications Distribution Methods Manual
23.	TIA	Telecommunications Industry Association
24.	UL	Underwriters Laboratories

PART 2 - PRODUCTS

2.1 GENERAL

A. All references to manufacturers, model numbers, and other pertinent information herein are intended to establish standards of performance and quality of construction.

1. When an approved manufacturer is noted with “no exceptions”, the required component shall be the manufacturer, type, series, and/or part number indicated. Alternatives will not be accepted.
2. When several manufactures are noted as acceptable and a specific manufacturer, type, series, part number, and/or specifications is indicated, this is to be used as the basis of design. The Contractor may substitute a component from another approved manufacturer that meets the specifications described.
3. “Approved alternates” must be approved, prior to bid, and if accepted by the Owner, will be issued to all Bidders, in writing, in the form of an addendum.

B. The products specified in this document do not necessarily constitute the exhaustive list of all products required to complete the project. The Contractor is responsible for providing all required parts and materials needed to deliver a complete and working system.

C. All products shall be recognized by a NRTL such as UL.

2.2 ACCEPTABLE MANUFACTURERS

A. Conduit, Boxes, and Fittings

1. ABB/Thomas & Betts
2. American Conduit
3. Atkore/Columbia-MBF
4. Owner approved alternate

B. Floor devices

1. nVent/Wiremold
2. Hubbell
3. FSR
4. Owner approved alternate

C. Basket tray

1. nVent/WBT
2. Legrand/Cablofil
3. Eaton/Flextray
4. Owner approved alternate

D. Fiber Optic Innerduct

1. Pyramid Industries
2. Carlon
3. Endot Industries
4. Owner approved alternate

E. Fabric Innerduct

1. MaxCell
2. Owner approved alternate

F. Non-Continuous Cable Supports

1. nVent/Caddy
2. Eaton/B-Line
3. Panduit
4. Owner approved alternate

G. Firestopping

1. Specified Technologies Inc (STI)
2. Hilti
3. 3M
4. Abesco
5. Owner approved alternate

H. Measured pull tape.

1. Neptco
2. Fiberteck
3. Condux International
4. Owner approved alternate

2.3 CONDUIT, BOXES, AND FITTINGS

A. All conduit, device boxes, pull boxes, and fittings shall be defined per the NEC and UL listed.

B. Conduit types

1. EMT shall comply with ANSI C80.3 and UL 797
2. IMC shall comply with ANSI C80.6 and UL 1242
3. GRC (RMC) shall comply with ANSI C80.1 and UL 6
4. LTC shall comply with CSA and UL requirements.
5. FMC use is not recommended.

C. Conduits larger than 1-inch shall have smooth mandrel bends. Bends may be premade manufacturer or may be created on-site with an appropriate bender capable of producing mandrel bends.

1. The minimum conduit centerline bend radius, for conduit 2-inches or smaller, shall be 6 times the conduit diameter.
2. The minimum conduit centerline bend radius, for conduit larger than 2-inches, shall be 10 times the conduit diameter.
3. A larger bend radius' may be required based on the installed cable media and type.

D. Conduit fittings

1. EMT fittings shall be steel compression style. Set screw fittings are not acceptable.
2. IMC/RMC fittings shall be metallic cast threaded style. Use an appropriate joint compound on fittings to lubricate, protect from corrosion, and enhance component connectivity.
3. Conduit bodies (i.e. LBs) are not permitted. "Smart" conduit bodies with internal radius control are allowed only if indicated on technology drawings or may be allowed with written pre-approval from the Design Consultant.

E. Device/Pull boxes

1. Shall be of metallic construction and shall comply with NEMA OS 1 and UL 514A
2. Box extensions shall be of the same material as the box.
3. Pull boxes shall have screw or hinged covers.
4. Gangable boxes are not allowed.

F. All components shall be coated for corrosion protection (e.g., galvanized, zinc plated, baked power coat, etc.).

G. Use the appropriate conduit and device box type for the environment in which it is installed.

1. Use RMC in hazardous areas such as fork-lift or pallet jack traffic, wet/damp locations, and/or for unrated cabling entering a building and extending more than 50-foot through the building.
2. Use NEMA 3R enclosures/pull boxes in wet/damp locations.
3. Use EMT for general interior building locations.
4. Use NEMA 1 enclosures/pull boxes for indoor locations.

H. A typical device box will consist of a 4-11/16 inch x 2-1/8 inch depth square box with a single-gang mud ring and a 1-inch (min) conduit to the accessible ceiling.

I. The typical floor device technology conduit size shall be 1-1/4 inch (min). Multiple technology conduits may be required at floor box locations. See drawings for details.

J. Pull boxes shall be sized per the following table:

Conduit trade size (maximum)	Minimum Pull Box Size (inches)			For each additional conduit increase pull box width by (inches)
	Width	Length	Depth	
1	4	16	3	2
1-1/4	6	20	3	3
1-1/2	8	27	4	4
2	8	36	4	5
2-1/2	10	42	5	6
3	12	48	5	6
3-1/2	12	54	6	6
4	15	60	8	8

2.4 SLEEVES

A. A floor sleeve shall consist of a bushed EMT conduit installed through a floor core in the sizes and quantities indicated on the drawings.

1. Sleeve/s shall protrude 6-inches (min) below the floor structure.
2. Sleeve/s shall be secured to prevent movement via strut and conduit strut clamps.

B. A non-fire-rated wall sleeve shall consist of a bushed EMT conduit installed through a wall assembly.

1. Sleeve/s shall be secured to prevent movement via locking collar, or similar solution, on each side of the wall assembly.

2.5 BASKET TRAY

A. Basket tray and basket tray accessories shall be UL listed.

B. Non-metallic accessories shall have a zero detectable halogen content as substantiated by a NRTL.

C. The basket tray shall be composed of high-strength wires formed into a 2-inch x 4-inch mesh pattern with intersecting wires welded together.

1. The tray shall have at least one (1) bottom longitudinal wire and one (1) longitudinal wire along each side of the tray. All wires shall be straight sections without bends.
2. In addition, there shall be one (1) additional longitudinal wire along each side which may, or may not, contain bends.
3. All wire end extremities shall be rounded during the manufacturing process to prevent cable damage and/or personnel harm during the life of the product.
4. Tray shall be available in 10-foot lengths, with depths/heights ranging from 2-inches to 6-inches, and widths ranging from 4-inches to 24-inches.
5. The tray shall be plated/coated to prevent corrosion. All tray and components shall have the same coatings for a particular building area (i.e., open ceiling areas may be different than accessible ceiling areas).

D. All basket trays and basket tray accessories shall be provided by a single manufacturer.

E. The following is a non-exhaustive list of common part numbers. Additional materials of different sizes, brackets, and other accessories will be likely be required. The following is to be used as a basis of design.

1. 2-inch height x 12-inch wide, pre-galvanized basket tray (WBT WBT2X12 S)
2. 4-inch height x 12-inch wide, pre-galvanized basket tray (WBT WBT4X12 S)
3. 4-inch height x 18-inch wide, pre-galvanized basket tray (WBT WBT4X18 S)
4. 12-inch termination support, pre-galvanized (WBT TERM SUPPORT 12)

5. 90° flat bend for 4-inch x 12-inch tray, pre-galvanized (WBT WBT-R90-4X12 PG)
6. Spice Kit (bolt/washer/nut), zinc plated (WBT SPLICE KIT)
7. Trapeze ceiling support bracket, 12-inch-wide tray, pre-galvanized (WBT CEILING SUPT 12)
8. Cantilever support bracket, 12-inch-wide tray, pre-galvanized (WBT SHELF SUPT 12)
9. Ground conductor to tray bolt (WBT GROUND BOLT).

F. Reference the drawings for basket tray sizing. Where sizing is not indicated, size tray as noted elsewhere within this specification.

G. Basket tray shall be bonded to local MDF/IDF grounding busbar/s via # 6 AWG, green sheath insulated, copper wire.

1. Ground lug at the busbar shall be 2-hole, irreversible compression crimp, long barrel design with inspection window.
2. Bond connection at the basket tray shall be accomplished via a manufacturer approved method (typically a split bolt and nut).

H. Basket tray shall be continuous in nature (i.e., no gaps). If a gap is absolutely necessary, the tray sections shall be bonded together via a # 6 AWG, green sheath insulate, copper wire and manufacturer approved ground conductor bond method.

2.6 INNERDUCT

A. Innerduct shall be required for fiber optic cabling that is not armored and is not installed in a dedicated conduit. Where innerduct is required, innerduct shall be installed in other pathway systems (e.g., basket tray, non-continuous cable supports, etc.).

B. The innerduct shall be non-metallic corrugated construction, UL listed with a UL 2024 flame propagation rating, have footage length markings, and have pre-installed pull tape/rope.

1. Plenum rated innerduct shall meet UL 910 standards for the NEC Article 770 and 800.
2. Riser rated innerduct shall meet UL 1666.

C. All innerduct shall be 1-inch or 1-1/4 inch in diameter and shall be sized to a maximum of forty percent (40%) fill.

D. All installed innerduct shall be of the same color (i.e., natural, white, or orange).

E. Only the innerduct manufacturer’s splices and enclosure connectors shall be utilized to make a complete and functional system.

2.7 FABRIC INNERDUCT

A. Fabric innerduct shall be installed within conduit as indicated on the drawings. Fabric innerduct installation allows for additional conduit capacity.

B. Fabric innerduct shall be halogen free, multi-cell design, pre-lubed to reduce cable pulling friction, and have pre-installed pull rope/tape in each cell.

1. For plenum areas, innerduct shall be UL 2024 OFCR FT-6 listed, 4-inch conduit, 3-cell (MaxCell MPX4003BKxxxx).

C. Install per manufacturer recommendations and recommended pulling swivels to prevent twists within the conduit.

2.8 NON-CONTINUOUS CABLE SUPPORTS

A. NCCS (non-continuous cable supports) shall be factory assembled for direct attachment to walls, hanger rods, all-thread, beam flanges, purlins, floor pedestals, etc. as required for the installation scenario. NCCS may be j-hooks and/or saddle bags.

1. NCCS shall be used for support outside of conduit and/or basket tray.
2. NCCS shall be installed at varying increments between 3-feet and 5-feet (max).
3. NCCS shall be installed at the transition into conduits and/or wall cavities and shall be used for supporting cable slack (i.e. figure 8 loops).

B. Cable supports shall have the following features:

1. Metallic flat bottom with radius edges with a minimum cable bearing support width of 1.625-inches, non-metallic large/gradual radius smooth cable bearing support, or 3-inch wide (min) flexible strap.
2. Have removable retainer clips to retain cabling within the j-hook or have provisions for installing hook & loop straps for cable retainage.

C. The following is a non-exhaustive list of common part numbers. Additional materials of different sizes and attachment methods will likely be required. The following is to be used as a basis of design.

1. 2-inch j-hook, for # 14 AWG thru ¼ inch wire or threaded rod, (Erico CableCat CAT324Z34)
2. 2-inch j-hook, ¼ inch diameter angle bracket, (Erico CableCat CAT32AB)
3. 2-inch j-hook, 1/8 inch to ½ inch flange beam clamp, (Erico CableCat CAT32BC)
4. 2-inch j-hook, plain wall mount, (Erico CableCat CAT32)

D. A NCCS shall not contain more than twenty-four (24) category 5e/6/6A cables regardless of size or capacity of such support.

E. The NCCS shall not contain multiple types of cabling (e.g., category 5e/6/6A cabling, multi-pair, fiber, coaxial, fire alarm, hybrid door access control, etc.). Provide separate supports for each cable type.

2.9 VERTICAL CABLE SUPPORT

A. It is recommended that vertical cables are secured to vertical cable runway. Where vertical cable runway is not feasible other methods shall be used.

B. Vertical cables installed for long distances shall have proper strain relief, to maintain manufacturer maximum tensile load and/or radial loads at transitions to the horizontal.

1. Wall mount vertical cable support, one-way cable locking mechanism, cable or cable bundle diameter or 2-inches (nVent/Erico CAT600WM).
2. Wire weave, Kellems style fiber support grip, 300 lb., 0.37 – 0.48-inch diameter cable (Hubbell 022291019).
3. Wire weave, Kellems style fiber support grip, 400 lb., 0.46 – 0.58-inch diameter cable (Hubbell 022291020).

2.10 FIRESTOPPING

A. All fire-rated building assemblies which are penetrated for cabling pathways shall be restored to the fire rating of the assembly with a UL approved system.

B. Main pathway firestopping devices shall be easily re-enterable (e.g., no puddy removal) and shall be self-sealing or have a torsional mechanical seal to allow for easy moves, adds, or changes (STI EZ-Path 44+ series).

1. Provide quantities indicated on the drawings or as required to match cabling pathway capacity directly before/after the fire-rated building assembly penetrated.
2. Provide all manufacturer mounting and ganging accessories for a complete and functional system.

C. Secondary pathway firestopping systems shall remain pliable and resilient to allow for the removal and/or addition of technology cabling, without the need to drill holes or chip out firestopping material (STI SpecSeal series).

D. Adjacent to each fire-rated building assembly cable penetration, the Contractor shall provide a permanent label at each side of the penetration with the following information:

1. Product installed (manufacturer, part number)
2. The UL System number
3. Date of installation
4. Installing Contractor and phone number

2.11 MEASURED PULL TAPE

A. Measured pull tape shall be provided in all conduit runs larger than 1-1/2 inches.

1. Pull tape shall be 1,800 lbs. (min) tensile strength, pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn with footage markers along the length of the tape, in 1-foot increments (Neptco WP1800P-xxxx).

PART 3 - EXECUTION

3.1 EXAMINATION/PREPARATION

A. Verify pathway routing and coordinate location/s with other trade’s building systems before installation. Ensure that proposed pathway routing eliminates interference with such systems and has sufficient clearances.

B. Verify that that pathway is properly sized for required cabling and future capacity, in advance prior to installation.

C. Verify that manufacturer recommended pathway loads will not be exceeded prior to installation.

3.2 GENERAL

A. All pathways shall be installed parallel and perpendicular to local corridors and interior walls.

B. Basket cable tray/ shall be required for narrow depth cable routes that would allow sags to rest upon the ceiling, electrical conduits, HVAC equipment, ducts, or lighting fixtures.

C. All pathway shall be placed with regard to the environment, EMI/RFI interference, and its effect on communication signal transmission.

D. Technology pathways shall not be installed adjacent utilities that may present a safety hazard or cause a degradation of system performance. The following are minimum technology pathway to other building system clearances:

1. Power cables and conduits - 1-foot parallel and 3-inches for a perpendicular cross
2. Ceiling tiles - 6-inches
3. Hot flues, steam pipes, hot water pipes and other hot surfaces - 24-inches.
4. Electrical panel boards - 3-feet
5. Fluorescent fixtures – 6-inches
6. Electrical motors and transformers – 6-feet
7. All-thread support rods - 2-inches

E. Support all pathways with dedicated pathway supports. Do not support communication pathway from the ceiling suspension system, electrical conduits, plumbing pipes, ductwork, or other building systems. Technology pathway supports shall be independently anchored to building structure.

F. Provide pathway attachment hardware and anchors designed for the structure to which it is attached. All hardware shall be designed to carry the weight of the pathway plus cabling at 100% fill. Confirm with Architect and/or General Contractor on installation procedures for cable support system prior to implementation.

G. All pathways installed for technology, through fire-rated building assemblies shall be properly firestopped, regardless of if it is used for cabling or left empty for future use.

H. All in-use and spare conduits/sleeves entering a telecommunications room or entrance facility shall be sealed to prevent the intrusion of water, gasses, and rodents both during construction and after construction.

I. Provide separation barriers between power and technology cables as required per the NEC.

J. Supports should be located where practicable so that connections between sections of the tray fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span for the application.

K. Upon approval, the Contractor shall be required to supply all labor, equipment, tools, and materials to create any additional penetrations not indicated on the drawings and shall provide the sleeve, temporary, and final fire stopping.

1. Special care shall be taken not to stress, overheat, or penetrate any building support member.
2. Coring shall be made with equipment appropriate for the dry penetration of concrete and block materials. Under no circumstances shall penetrations be made utilizing a chisel or percussion type equipment.
3. Concrete, block, or plaster cores shall be made by dry saw/core methods only.
4. The Contractor must consult with the building Architect or Engineer, prior to drilling, coring, or sawing of any wall, floor, etc. All penetrations shall be made at approved, appropriate, locations.

3.3 CONDUIT

A. All outlet device box conduit/s shall be routed up past the ceiling plane, over/across inaccessible ceiling types (e.g., gypsum) and/or through open ceiling areas, as relevant, to the nearest accessible ceiling space whether or not indicated on the drawings.

B. Conduit shall be installed level and plumb.

C. Each device box and/or floor device shall have dedicated technology conduits unless noted otherwise on the drawings. “Daisy chaining” of device boxes or floor boxes with technology conduit is prohibited.

D. Conduit shall be routed toward, not away from, the feeding MDF/IDF to maintain cable lengths to a minimum.

E. Accessible pull boxes are required in conduit runs as follows:

1. If the conduit run is longer than 100-feet.
2. If the run has more than two (2) 90° bends, provide an accessible pull box between sections of two (2) bends or less.
3. If a conduit run requires a reverse bend (between 100° and 180°), provide an accessible pull box at each bend having an angle from 100° to 180°.

F. If a conduit run must require three (3) 90° bends between pull boxes, then derate the conduit capacity by fifteen percent (15%) or use the next larger trade size conduit. A third bend may be acceptable without derating or increasing the conduit size if the total conduit run is less than 33-feet or one of the bends is located within 1-foot of the cable feed end. All scenarios with three (3) 90° bends between pull points require written pre-approval by the Design Consultant.

G. A conduit offset counts as one (1) 90° bend.

H. Never use a pull box for a bend. All conduits shall be terminated across from each other within the pull box and the conduit bend/s shall be placed directly before/after the pull box.

I. Pull box covers shall be accessible both during construction and after construction. Coordinate any required pull box access (e.g., ceiling access panel) with the Architect.

J. When exposed to weather, water, or other liquids UV rated LTC may be used if its total length is less than 3-feet.

K. FMC is not recommended, but in certain cases may be used. FMC can be used if its total length is less than 3-feet in a single conduit run and it is securely anchored to the building structure at 1-foot intervals to prevent movement during cabling installation.

L. All conduit bends shall be accomplished with an approved bending device which does not crush, deform, or damage the surface finish of the conduit.

M. Ream all conduit ends, remove cutting lubricants, and fit each with an insulated bushing to eliminate sharp edges/burrs that may cause damage to cabling during installation or service.

N. Provide nylon pull cords, with a test rating of 200 lbs. (min), in conduit runs.

1. Pull cords shall be securely tied/anchored at each run extremity.
2. Measured pull tape with higher tensile strength is required in 1-1/2 inch or larger conduit runs.

A. All device boxes and pull boxes shall be independently secured to the surrounding building structure via appropriate hardware designed to carry the box, cabling, and cabling installation forces.

B. Do not mount device boxes back-to-back within the same wall stud cavity to minimize sound transmission between rooms.

C. All conduits shall be secured at NEC recommended intervals using 1-hole clamps, conduit hanger clamps, and/or strut and strut clamps. All supports shall be secured or hung from the building structure with appropriate hardware designed to carry the conduit, cabling, and cable installation forces.

D. Conduits shown to terminate horizontally at a wall, shall be terminated 4-inches past the wall.

E. Floor conduit stub-ups/sleeves shall terminate 4-inches above the finished floor and shall be aligned parallel to, and within 4-inches of, the wall.

1. Floor conduits shall be capped to prevent debris entry.

F. Conduit runs less than 3-feet in length do not require bonding to an earth ground. All other conduit runs shall be properly bonded to an appropriate building ground using a conduit bonding clamp or bushing.

G. Where conduit extremities are not permanently concealed (e.g. within a wall) and at pull box terminations, label conduit with “far end” location.

H. All conduits shall be concealed whenever possible. When this is not possible coordinate with the Architect to determine cosmetic finishes.

I. Where security cameras and/or wireless access points are located on the exterior of a building wall, provide a ¾-inch RMC conduit through the wall. On the outside of the building provide a threaded cap which can be removed for connection to a future weatherproof device box/enclosure.

J. Roof penetrations for technology pathway will consist of a 2-inch RMC conduit extending from 30-inches above the roof to 18-inches (min) below the roof.

1. Penetration shall typically be located above, or very close to, a 2-hour MDF/IDF or building riser room.
2. Conduit penetration shall be properly sealed to prevent water ingress with an appropriate flashing device. Coordinate installation with the roofing Contractor.
3. Conduit shall be anchored to the building structure below the roof deck for stability.
4. An appropriate weatherhead assembly shall be provided at the top of the conduit to prevent water ingress.
5. Within the building, extend the RMC conduit to the MDF/IDF or building riser room.

3.4 BASKET TRAY

A. Join tray sections with manufacturer approved splicing methods. In addition to the manufacturer splicing method, at least one (1) splice bolt/washer/nut shall be used at each tray splice.

B. Basket tray tees, crosses, flat bends, elevation changes, width reductions, etc. shall be created with manufacturer approved methods, components, and hardware.

1. All tees, crosses, and flat bends shall be created with large radius sweeping bends.
2. Straight sections of the tray system shall be created with tray sections of 8-feet (min) in length. Do not create straight sections of basket tray with short, left over, sections which are less than 8-feet in length.
3. Vertical elevation changes shall be gradual in nature, with slopes to the horizontal being less than ± 22.5° (max).

C. Cut wire basket tray members square with a manufacturer approved cutting tool as to leave no sharp edges at the cut point. File member ends, as required, to remove burrs before installation.

D. Support basket tray via manufacturer approved trapeze or cantilever support method.

1. Support tray at 8-foot (max) intervals. If the manufacturer recommended intervals for tray at one hundred percent (100%) fill with standard category 6 cabling are less than 8-feet, use the manufacturer recommendation.
2. Always support tray within 6-inches of extremities and within 1-foot of bends and elevation changes.
3. All tray support hardware and building anchors shall be designed to carry the weight of the tray, cabling, and cable installation force. Minimum all-thread size shall be 3/8 inch.

E. Basket tray shall be installed level from side-to-side (width) and along it's axial length. Changes in elevation shall be accomplished via a manufacturer approved elevation change method.

F. Where basket tray intersects fire-rated walls:

1. Terminate and secure the basket tray on each side of the wall with a wall angle bracket.
2. Provide UL approved, re-enterable firestopping assembly/s with collective cable capacity equal to the basket tray cable capacity at fifty percent (50%) cross-sectional area fill (i.e., 100% full).

G. Where basket tray intersects non-fire-rated walls, either:

1. Frame out the wall, with studs, to the dimensions of the basket and reseal the opening per the intended use of the wall assembly (e.g., smoke, sound, gas/odor mitigation) upon cable installation or service.
2. Terminate and secure the basket tray on each side of the wall with a wall angle bracket. Provide sleeve/s with collective cable capacity equal to the basket tray cable capacity at fifty percent (50%) cross-sectional area fill (i.e., 100% full). Reseal the opening/s per the intended use of the wall assembly (e.g., smoke, sound, gas/odor mitigation) upon cable installation or service.

H. A minimum of 12-inches of access headroom shall be provided and maintained above basket tray. Care shall be taken to ensure that other building systems do not restrict access to basket trays. There shall be a 2-foot x 2-foot access area adjacent to the tray, on one side, at 12-foot length intervals and at tray bends to allow for cable installation and service.

I. For painted tray, paint shall be thoroughly removed at bonding points between adjacent sections, to provide electrical continuity between sections.

J. Ensure that all bonded connections between tray sections have 0.1 milliohm (max) resistance between adjacent sections.

3.5 NON-CONTINUOUS CABLE SUPPORTS

A. Pendent supported NCCS shall be installed on dedicated support hardware that is secured to the overhead building structure. NCCS shall never be attached to ceiling grid wires.

1. Multiple NCCS may be installed on a single support method (e.g., same all-thread).
2. For low-capacity cable runs (i.e., less than seven 4-pair cables), NCCS may be installed on a dedicated # 12 AWG wire.
3. For higher-capacity cable runs, NCCS shall be supported from a ¼-inch (min) to 3/8-inch all thread.
4. At corners or where multiple j-hooks are utilizing the same support, 3/8-inch (min) all thread shall be used.
5. All support hardware shall be of sufficient design/strength so that the NCCS remains in the proper orientation for which it is designed.

B. NCCS shall be installed so that cable sag between consecutive NCCS shall be between 3-inches (min) and 6-inches (max).

3.6 VERTICAL CABLE SUPPORT

A. Support all vertically placed cabling via one of the following methods:

1. Vertically installed cable runway (See section 27 10 10).
2. Vertical backbone cable support assembly with one-way locking mechanism
3. Wire weave Kellems style grip and stranded steel tie cable which is anchored to the building structure.

B. Vertical cable support style and/or quantity must be carefully chosen to properly support the cable's weight without crushing/deforming the cable sheath.

3.7 FIRESTOPPING

A. Coordinate all firestopping procedures and components with the General Contractor and obtain written approval prior to purchase and installation.

B. Confirm that chosen firestopping system is valid for the fire-rated building assembly type and penetration type (e.g., conduit, cable, etc.) with the manufacturer and install system per manufacturer's drawing and instructions. Provide completed firestopping label on both sides of the building assembly being restored.

3.8 VERIFICATION AND TESTING

A. Test all system pathways to ensure bonding to earth ground.

B. Ensure all conduit runs have pull cords installed that are properly anchored at the run ends.

C. Ensure all floor conduit stub-ups are sealed to prevent debris ingress.

END OF SECTION

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SECTION 27 10 10

VOICE AND DATA CABLING DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. The purpose of the voice and data structured cabling infrastructure system is to provide standardized communications channels between user workstations (e.g., phones and computers) and other edge devices (e.g., wireless access points, security cameras) and the information transport equipment located within the building/campus telecommunications equipment rooms.

B. A standardized cabling infrastructure provides:

1. Adheres to industry standards, ensuring compatibility of various devices and systems.
2. Allows for easy expansion and adaptation for new technologies/requirements without extensive rework.
3. Simplifies maintenance and management by reducing downtime and making troubleshooting easier.
4. Ensures high-performance signal transmission and network performance.
5. Enhances the overall reliability of the network ensuring continuous and uninterrupted connectivity.

C. Proper installation and management of the voice and data structured cabling infrastructure is crucial for ensuring optimal network performance and uptime.

D. This section includes the minimum requirements necessary for the voice and data structured cabling infrastructure.

E. The Drawings indicate needs for the project (e.g., devices, device locations, quantities, connectivity, etc.) and the specifications describe the components required and how to install such components. Not all sections of this specification may be relevant to all projects. For example, if intra/inter-building backbone cabling is not indicated on the drawings, it is not a requirement for the project.

1.2 WORK INCLUDES

A. The voice and data structured cabling infrastructure is composed of the following:

1. Providing the buildout of technology equipment rooms, including but not limited to, racks, cabinets, vertical and horizontal wire management, cable runway, cabling entrance/exit sleeves and/or fire stopping, and bonding to an existing local grounding busbar.
2. Providing the balance of all communications cabling pathways (see Section 27 05 28 for more information) that are required for communications cabling placement.
3. Providing interbuilding communications links, including but not limited to, cabling, cable bonding, cable termination, cable labeling, and cable testing.
4. Providing intrabuilding communications links, including but not limited to, cabling, cable bonding, cable termination, cable labeling, and cable testing.
5. Providing horizontal cabling links, including but not limited to, cabling, cable termination, cable labeling, and cable testing.
6. Providing a complete powered fiber optic cable solution for site light pole cameras.
7. Providing copper patch cables and fiber optic patch cords
8. Providing uninterruptible power supplies and power distribution units (power strips)
9. Network switch equipment and associated equipment is furnished and racked and stacked in Section 27 20 00.

a. Installation of category 6A interconnect cables shall be by the structured cabling system Contractor.
b. Final configuration of this equipment shall be by Owner.

10. Mounting and patching wireless access points and antennas furnished in Section 27 20 00. Final configuration of this equipment shall be by Owner.

B. The Contractor shall provide all installation equipment, materials, labor, supervision, test equipment, and services necessary for or incidental to the installation and testing of the complete voice and data cabling distribution plant as indicated on the drawings and specifications.

C. Reference Related Sections for work provided by other trades, for communications, as specified in this section and as indicated on T-series drawings.

D. Work provided by other trades, for communications, as specified in this section and/or as indicated on T-series drawings shall include:

1. Equipment room wall plywood backboards. Plywood backboard for wall mounted cabinets, outside of dedicated equipment rooms, shall be provided by the Division 27 Cabling Contractor.
2. Equipment room power outlet receptacles

E. Provide all documentation and training as outlined in these specifications.

F. Provide a complete structured cabling system manufacturer extended warranty as outlined in these specifications.

1.3 SYSTEM REQUIREMENTS

A. Provide a standards compliant structured cabling infrastructure to be used for information transport. This cable plant will predominantly be used for telephones, computers, printers, wireless access points, security cameras, and other internet protocol devices.

B. Provide the complete infrastructure buildout for Main Distribution Frame (MDF) and Intermediate Distribution Frame (IDF) room. Each MDF/IDF room shall have:

1. Proper vertical and horizontal cable pathway capacity for backbone and horizontal cabling between the racks/cabinets and room perimeter wall/s.
2. Floor or wall mounted equipment racks/cabinets for cabling infrastructure termination, horizontal cable management, active equipment, and spare future capacity.
3. Vertical cable management within the racks/cabinets.

C. Provide network connectivity between the new Arena Building MDF and the existing Administration Building MDF and between the Arena Building MDF and the Middle School IDF.

1. The backbone shall provide high speed performance up to 10Gbps.

D. The data network backbone between a building's MDF and each IDF room shall be installed in a star topology. As such, each IDF will have a single dedicated link to the MDF.

1. The backbone shall provide high speed performance up to 10Gbps.

E. Horizontal cabling shall be installed from the MDF/IDF to user Work Area Outlets (WAOs) and/or edge devices in a star topology.

1. The horizontal data cabling infrastructure shall meet, or exceed, category 6A standards and will be capable of transmitting Power Over Ethernet (PoE).
2. The category 6A infrastructure shall consist of Unshielded Twisted Pair (UTP) cabling.

F. The infrastructure shall be provided with fiber optic patch cords and copper patch cables to create a complete system channel.

1.4 RELATED SECTIONS

A. Related work specified in other sections

1. Section 27 05 00 – Common Work Results for Communications
2. Section 27 05 26 – Grounding and Bonding for Communication
3. Section 27 05 28 – Pathways for Communications Systems
4. Section 27 20 00 – Data Communications Equipment
5. Section 27 30 00 – Voice Communications Equipment

1.5 REFERENCES

A. Perform all work in strict accordance with the requirements and recommendations stated in the codes, regulations, and standards except when requirements are exceeded by the contract documents.

B. Strictly adhere to all BICSI, TIA, EIA, and NEC documentation for industry standard recommendations, practices, and codes when installing telecommunications infrastructure.

C. Specific reference to specifications, codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of the contract.

D. Codes, Regulations, and Standards

1. All applicable parts will be FCC Class B approved.
2. All applicable parts will be Underwriters Laboratories, Inc. approved.
3. All requirements of the local Authority Having Jurisdiction (AHJ).
4. Americans with Disabilities Act.
5. ANSI/EIA-310-D Cabinets Racks Panels and Associated Equipment
6. ANSI/ICEA S-83-596 Fiber Optic Premises Distribution Cable.
7. ANSI/ICEA S-87-640 Fiber Optic Outside Plant Distribution Cable.
8. ANSI/IEEE Standard 802.3 also known as ISO 8802-3 - Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications. Ethernet UTP 10 Base-T, Fiber Optic 10 Base-FX.
9. ANSI/TIA/EIA-492AAAC Detail Specification for 850nm, Laser Optimized 50um Core Diameter/125 Um Cladding Diameter Class 1a Graded Index Multimode Optical Fibers.
10. ANSI/TIA/EIA-492CAAA Detail Specification for Class Iva Dispersion-Unshifted Single mode Optical Fibers
11. ANSI/TIA/EIA-526-14-A Optical Power Loss Measurements of Installed Multi-Mode Fiber Plant: OFSTP-14A
12. ANSI/TIA/EIA-526-7 Optical Power Loss Measurements of Installed Single-Mode Fiber Plant: OFSTP-7
13. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard (and all Published addenda), Part 1: General Requirements
14. ANSI/TIA/EIA-568-B.2-10:2008 Transmission Performance Specifications for 4-Pair 100 Ohm Augmented Category 6 Cabling.
15. ANSI/TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard.
16. ANSI/TIA/EIA-569-B Commercial Building Standards for Telecommunications Pathways and Spaces
17. ANSI/TIA/EIA-598 Color Coding of Optical Fiber Cables.
18. ANSI/TIA/EIA-604 (SERIES) FOCIS Fiber Optic Connector Intermate ability Standard.
19. ANSI/TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure
20. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
21. ANSI J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications.

22. ANSI/TIA/EIA-758 Customer-Owned Outside Plant Telecommunications Cabling Standard.
23. ANSI/TIA-568-C.2 Commercial Building Telecommunications Cabling Standard.
24. ANSI/TIA-569-C Commercial Building Standard for Telecommunications Pathways and Spaces.
25. CENELEC EN 50289-1-14 Coupling attenuation or screening attenuation of connecting hardware.
26. DIN IEC 60068 Basic environmental testing procedures.
27. EIA-364 Electrical Connector/Socket test Procedures Including Environmental Classifications.
28. Federal Communications Commission (FCC) Title 47, Code of Federal Regulations, Part 68: Connection of Terminal Equipment to the Telephone Network
29. IEC 60603-7-51. Ed. 1.0 Detailed specification for 8-way, shielded free and fixed connectors, for data transmissions with frequencies up to 500 MHz.
30. IEEE 802.3-2002 Information Technology - Telecommunication & Information Exchange Between Systems - LAN/MAN - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
31. IEEE 802.3AE IEEE Standard for Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Media Access Control (MAC) Parameters, Physical Layer and Management Parameters for 10Gig Operation.
32. IEEE 802.3AF Data Terminal Equipment (DTE) Power Over Media Dependent Interface (MDI)
33. IEEE 802.3AN Physical Layer for 10Gig (10GBASE-T) operation over balanced twisted pair structured cabling systems.
34. IEEE 802.3AT (Current Draft) Data Terminal Equipment (DTE) Enhanced Power Over Media Dependent Interface (MDI).
35. IEEE Standard 802.3u Fast Ethernet UTP 100 Base-Tx, 100 Base-T, 100 Base-T4, Fiber Optic 100 Base-FX.
36. Information Transport Systems Installation Manual current edition Building Industry Consulting Services International (BICSI)
37. International Building Codes (IBC).
38. ISO / IEC 60603-7-1 First Edition. 2002 Detailed Specification for 8-way, shielded free and fixed connectors with common mating features.
39. ISO/IEC 11801 ed. 2.1 Amd 2:2008 Information Technology - Generic Cabling for Customer Premises.
40. ISO/IEC 14763-1 Information Technology – Implementation and Operation of Customer Premises Cabling – Part 1: Administration
41. ISO/IEC 18010 Information Technology – Pathways and Spaces for Customer Premises Cabling
42. Local and State Building Codes.
43. NFPA 101, Code for Safety to Life from Fire in Buildings and Structures.
44. NFPA 70, National Electrical Code.
45. Telecommunications Distribution Methods Manual current edition Building Industry Consulting Services International (BICSI)
46. Texas Accessibility Standards.
47. TIA/EIA TSB 67 Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.
48. TIA/EIA-TSB-125 Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning
49. TIA/EIA-TSB-140 Additional Guidelines for Field Testing Length Loss and Polarity of Optical Fiber Cabling Systems
50. Texas Accessibility Standards.
51. Local and State Building Codes.

1.6 QUALITY ASSURANCE

A. Contractor Qualifications

1. The Contractor shall be regularly engaged in the installation of communications infrastructure systems and have a minimum of five (5) years' installation experience with systems similar to those required for this project.
2. Recently formed companies are acceptable only if specific pre-approval is requested, and granted by the Architect/Engineer, based on experience of key personnel, current and completed projects, and all licensing requirements are met 10 working days prior to the contract proposal date.
3. The Contractor shall have an office within 50-miles of the project site which is staffed with trained technicians who are qualified and licensed to perform and supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent

operational audit of all installed devices, to instruct the Owners representatives in the proper operation of the system, and to provide service throughout the warranty period.

4. The Contractor shall be capable of dispatching technicians to repair a system within 6-hours of a service request
5. The Contractor shall provide references to include client names, phone numbers, and a summary of project details. These references will be checked, and references will be asked questions relative to the performance of the Contractor. This project reference list must contain at least two (2) projects within a 100-mile radius of the project to allow site for review of the system installation and service. Each reference project listed must utilize equipment by the same manufacturer as the proposed system.
6. The Contractor shall provide verification documentation that all installation personnel have been properly trained to install the products described in this section.
7. The Contractor shall own all tooling and equipment required for system installation such as, but not limited to, hammer drills, bandsaws, powder actuated nail guns, and fiber optic and copper cable testing equipment.
8. The Contractor shall dedicate a full-time project manager with a minimum of ten (10) years' field experience in installation of the specified system. A project manager shall be assigned for the duration of the project and shall not be replaced without written consent from the Owner.
9. The Contractor shall employ a BICSI certified RCDD 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 guidance as required.

B. The Contractor, as a business entity, shall be a local Panduit Certified Partner, who has been trained on the latest standards and installation practices and who shall provide a 25-year Panduit Certification System Warranty for this project.

1. No contract employees are allowed unless they have been through the manufacturer training within the last 18-months. A certificate of this training shall be provided with the Contractors' submittal.

C. Contractors who do not currently possess the necessary qualifications, trained and experienced personnel, financial capacity, or do not meet other requirements as described herein will be disqualified.

D. The Contractor shall not have any grievances or complaints of record regarding workmanship, code compliance, or service response. A Contractor that has any prior finding/s of a code violation or has any litigation in process concerning the installation of a cable plant is unacceptable.

E. The ability of a Contractor to obtain plans and provide a performance bond shall not be regarded as the sole qualification of the Contractors' competency and responsibility to meet the requirements and obligations of the contract.

F. The Owner may investigate, as they deem necessary, to determine the ability of the proposed Contractor to perform the work. The proposed Contractor shall furnish, to the Owner, any information or data requested for this purpose.

G. The Owner reserves the right to reject any contract proposal if the evidence submitted, or their investigation, fails to indicate that the Contractor is qualified to fulfill any part of the contract or to complete the work described herein.

H. The Owner reserves the right to reject the proposal of any Contractor who has previously failed to perform properly or complete on time any contracts of a similar nature.

I. System installation shall be performed in a neat and workmanlike manner.

J. All 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.

K. Where requirements between governing codes and regulations vary, the more restrictive provision shall apply.

L. Nothing in the contract documents shall grant authority or permission to disregard or violate any legal requirement.

1.7 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Provide all submittal requirements under this section in a single submittal package.

D. Provide product data for each type of product. This list is not inclusive of all required product data.

1. Racks, cabinets, wire managers, cable runway, grounding
2. Non-continuous cable supports
3. Inter-building backbone, intra-building backbone, and horizontal cables
4. Sleeves and firestopping devices/assemblies
5. Fiber optic backbone termination components
6. Copper backbone termination components
7. Horizontal cable termination components at the equipment room
8. Horizontal cable termination components at the work area outlet or edge device
9. Fiber optic patch cords
10. Copper patch cables
11. Labeling components
12. Custom boxes, etc.

E. Product data submittal requirements:

1. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting Sub-Contractor.
2. Include on or after the cover sheet sufficient space for review stamps.
3. Provide a product data index and complete material/equipment list for each product submitted.
4. For any deviations from the Contract Document requirements, including variations and/or limitations, provide descriptions of such. Show any revisions to equipment layout required by use of selected equipment.
5. Provide cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by **prominent** notation (e.g., an arrow, box, circle, or other means) on each sheet the exact product and options being submitted.
6. For each product identify the manufacturers name, part number, and selected options and colors.
7. Submit design data, when the scope of work requires such, including calculations, schematics, risers, sequences, or other data.
8. Submit a sample of the extended product warranty language.

F. Any resubmittal shall include a complete revised material/equipment list along with revised product data.

G. Provide floor plan Shop Drawings, in pdf electronic format, indicating:

1. Equipment room locations and names
2. Main pathway routing and support types and sizes
3. Work area outlet and edge device locations, configurations, and identification labeling

H. Shop Drawings shall locate all components of the system. Shop Drawings shall include information that will allow to the Contractor to coordinate interdisciplinary work and when necessary, guide the manufacturer or

fabricator in producing a product. Shop Drawings shall be specifically prepared to illustrate the submitted portion of work, this may require diagrams, schedules, details, and accurately scaled equipment and device layouts prepared using a CAD or BIM engineering drawing program.

I. Submit a complete submittal package within thirty (30) calendar days after award of this work for approval.

1. Materials or equipment shall not to be ordered without written approval.
2. Partial submittals are not acceptable for review.
3. Each submittal shall include a dated transmittal.

J. Submittal/s shall be electronically transmitted in pdf electronic file format (preferred).

1. Paper copies may be provided in quantities indicated in Division 01.
2. Paper copies shall be organized including index tabs in an appropriately sized 3-ring binder.

1.8 PERMITS

A. The Contractor shall secure and pay for all required permits and fees required for the execution of this work. Work shall not commence until all permit applications have been approved.

1.9 SCHEDULING

A. The Contractor shall comply with all scheduling requests established by the Owner, both prior to commencing Work, and during construction. The Contractor shall provide a detailed schedule of work to be performed.

B. As/If required for the project, work shall be scheduled so as not to interfere with day-to-day operations of the facility.

C. The Contractor will be responsible for achieving a complete and fully functional installation on or before the contract scheduled completion date.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in containers in manufacturer/factory packaging. Store materials in a clean and dry space and protect products from damage. Handle materials in accordance with manufacturer’s recommendations to avoid damage.

B. Material storage space on the project site may be limited. The Contractor shall coordinate delivery and arrange storage of materials and equipment with the Owner. Contractor may need to allow for material storage in a Contractor provided storage container.

C. The Contractor shall be responsible for on-site security of materials, tools, and test equipment.

D. The Contractor shall provide protective coverings, as required during construction, to prevent damage to installed components.

E. At no expense to the Owner, the Contractor shall replace components/materials damaged during storage, handling, or installation throughout the construction duration.

1.11 PROJECT CONDITIONS

A. Verify all site conditions applicable to this work. Notify the Architect of discrepancies, conflicts, or omissions in writing promptly upon discovery.

1.12 CONFLICTS

A. This installation shall be made in strict accordance with the specifications, drawings, all applicable codes, and practices referenced in publications and standards. In case of conflicts between the aforementioned, notify the Owner in writing prior to commencement of affected work.

1.13 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements.

B. Provide Record Drawings, in pdf electronic format, indicating:

1. Equipment room locations and names
2. Main pathway routing and support types and sizes
3. Work area outlet and edge device locations, configurations, and identification labeling

C. Provide all cable test results in both pdf electronic format and native test equipment electronic format. Provide viewer/s capable of viewing all native format tests. All tests should have the following information:

1. Cable test equipment manufacturer, model number, serial number, hardware version, and firmware version (should be latest version).
2. Cable identification and project name
3. Autotest used
4. Tests results
5. Overall pass/fail indication. Test results shall yield a 100% PASS rating. Tests with the “* PASS” (note asterisk) will not be accepted.
6. Date of the test

1.14 WARRANTY

A. Contractor shall warrant all materials and labor 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. Contractor shall repair or replace defects occurring in labor or product within the warranty period without charge.

B. The Contractor, as a business entity, shall be a local Panduit Certified Partner, who has been trained on the latest standards and installation practices and who shall provide a 25-year Panduit Certification System Warranty for this project. This warranty shall cover defects in material and workmanship, assure the system meets or exceeds ANSI/TIA standards at the time of installation, and guarantee support for current or future applications designed for transmission over the installed system performance.

C. Any materials/components replaced during the warranty period shall have a warranty matching that of the original part from date of replacement.

1.15 DEFINITIONS AND TERMS

A. Trade names for communications components and sub-systems are often abbreviated. The following acronyms and/or abbreviations may be referenced within this section.

1. AFF Above Finished Floor
2. ANSI American National Standards Institute
3. AWG American Wire Gauge
4. BET Building Entrance Terminal
5. BICSI Building Industry Consulting Services International
6. EF Entrance Facility
7. EIA Electronic Industries Alliance
8. EMT Electrical Metallic Conduit
9. FDC Fiber Distribution Center
10. IDC Insulation Displacement Connector
11. IDF Intermediate Distribution Frame
12. IMC Intermediate Metal Conduit
13. IP Internet Protocol
14. MDF Main Distribution Frame
15. NCCS Non-Continuous Cable Support
16. NEC National Electric Code
17. NEMA National Electric Manufacturers Association
18. NFPA National Fire Protection Association
19. NRTL Nationally Recognized Testing Laboratory
20. OSP Outside Plant
21. PBB Primary Bonding Busbar
22. PDU Power Distribution Unit
23. RBC Rack Bonding Conductor
24. RCDD Registered Communications Distribution Designer
25. RMU Rack Mount Unit
26. SBB Secondary Bonding Busbar
27. TDMM Telecommunications Distribution Methods Manual
28. TEBC Telecommunications Equipment Bonding Conductor
29. TIATelecommunications Industry Association
30. UL Underwriters Laboratories
31. UPS Uninterruptible Power Supply
32. UTP Unshielded Twisted Pair
33. WAO Work Area Outlet

PART 2 - PRODUCTS

2.1 GENERAL

A. All references to manufacturers, model numbers, and other pertinent information herein are intended to establish standards of performance and quality of construction.

1. When an approved manufacturer is noted with “no exceptions”, the required component shall be the manufacturer, type, series, and/or part number indicated. Alternatives will not be accepted.
2. When several manufactures are noted as acceptable and a specific manufacturer, type, series, part number, and/or specifications is indicated, this is to be used as the basis of design. The Contractor may substitute a component from another approved manufacturer that meets the specifications described.
3. “Approved alternates” must be approved, prior to bid, and if accepted by the Owner, will be issued to all Bidders, in writing, in the form of an addendum.

B. The products specified in this document do not necessarily constitute the exhaustive list of all products required to complete the project. The Contractor is responsible for providing all required parts and materials needed to deliver a complete and working system.

C. All equipment and components shall be new, and the manufacturers' most current model iteration. All like devices shall be of the same manufacturer and model number.

D. Only equipment devices have been shown on the contract drawings. Specific wiring between equipment has not been shown though is required for a complete system.

E. All products shall be recognized by a NRTL such as UL.

2.2 ACCEPTABLE MANUFACTURERS

A. Proposed Contractors wishing to propose any product substitution must do so in writing to the specifying authority at least ten (10) days prior to the proposal opening.

B. For manufacturers materials, equipment, or models other than that specified, the proposed Contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment. Proposals must include detailed information showing all deviations from the system as specified.

C. Substitute products for which the proposed Contractor does not obtain prior approval will not be considered acceptable for this project. Final approval of any alternate products shall be based on the decision of the Owner and Architect.

D. It is the responsibility of the Contractor to provide all features and functions as outlined in these specifications. The functions and features specified are vital to the operation of this facility; therefore, inclusion in the list of acceptable manufacturers does not release the Contractor from strict compliance with the requirements of this specification.

E. Equipment Racks, Cabinets, Cable Runway

1. Chatsworth Products Incorporated (i.e., CPI)
2. Panduit
3. Eaton/B-Line
4. Owner approved alternate

F. Vertical/Horizontal Cable Management

1. Chatsworth Products Incorporated (i.e., CPI)
2. Panduit
3. Eaton/B-Line
4. Owner approved alternate

G. Fiber Optic Cabling

1. Corning Cable Systems (no exceptions)

H. Fiber Optic Cable Connectors and Hardware

1. Panduit or Corning Cable Systems (no exceptions)

I. Horizontal Cabling

1. Panduit or General Cable (no exceptions)

J. Outside Plant Category 6 Cabling

1. General Cable

2. Superior Essex
3. Owner approved alternate

K. Cabling Surge Protection

1. CircaMax
2. Ditek
3. Owner approved alternate

L. Horizontal Cable Termination Components

1. Panduit (no exceptions)

M. Firestopping Assemblies

1. Hilti
2. Specified Technologies Incorporated (STI)
3. Abesco
4. Owner approved alternate

2.3 TELECOMMUNICATIONS SPACE BUILDOUT

A. Refer to drawings for infrastructure layout requirements (e.g., placement, quantity, sizing) for each telecommunications space.

B. 2-post equipment racks shall have the following properties; aluminum extrusion construction, 19-inch equipment mounting, 7-foot height, 45 RMUs, black in color, 3-inch channels, #12-24 threaded tapped rails, marked RMUs, and 1,000 lb (min) load capacity [CPI 55053-703].

C. One (1) 10-inch wide vertical wire manager shall be installed on each side of each rack and/or between adjacent racks unless otherwise indicated on the drawings. Vertical wire managers shall have the following properties; black in color, double-sided, a height equivalent to the adjacent equipment rack/s, slack management and strain relief for patch cables/cords, and front and rear toolless removable hinged doors [CPI Velocity 13914-703]. Velocity cable spool kit [CPI 13935-701] and lashing bar kit [CPI 13928-001].

D. Horizontally installed cable runway shall be installed at an elevation of 90-inches AFF. Both horizontal and vertically installed runway shall have the following properties; black in color, welded steel design, cross-members at 12-inch intervals (max), widths of 12, 18, and 24-inches [CPI 10250-7xx where “xx” is the width in inches]. Note, cable runway installed parallel to and over the racks and vertical wire management in a row shall be adjustable rung runway in widths of 12, 18, and 24-inches [CPI 14300-7xx where “xx” is the width in inches].

1. Runway splices shall be accomplished with black 180° butt splice kits [CPI 11301-701] and/or black 90° junction splice kits [CPI 11302-701].
2. All “open ends” of horizontally installed cable runway shall have a black end closing kit installed [CPI 11700-7xx, where “xx” is the runway width in inches].
3. Horizontally installed runway shall be secured to walls via black wall angle support kits [CPI 11421-7xx, where “xx” is the runway width in inches] and black triangular support brackets [CPI 11312-712 (12”), 11312-718 (18”), 11746-724 (24”)].
4. Horizontally installed runway shall be secured to equipment racks with a black 3-inch channel rack-to-runway mounting plate [CPI 10595-7xx, where “xx” is the runway width in inches] and a black 6-inch elevation kit [CPI 10506-706].
5. Horizontally installed runway shall be supported from the overhead building structure as required. Runway supports shall be trapeze design consisting of two (2) brackets [CPI 11408-001] and 3/8-inch (min) threaded rod secured to the overhead building structure. Black nylon threaded rod covers shall be installed on each threaded rod from the runway elevation plus 6-inches. All all-thread shall be cut and deburred to prevent harm to personnel. All visible support hardware shall be black in color.

6. All horizontally installed runway shall be supported at 5-foot (max) intervals by either walls, racks, or the overhead support method.
7. Wall mounted vertical runway shall be secured to the floor via a black cable runway foot kit [CPI 11309-701] and secured to the wall via black vertical wall brackets [CPI 10608-701] at equidistant intervals not to exceed 3-foot.

E. Above each rack's vertical cable manager, a black radius cross-member drop shall be installed to limit cable strain along the transition between the vertical wire manager and the horizontally installed cale runway [CPI 14304-7xx, where "xx" is the radius width in inches]. Provide two (2) radius drops where cabling transitions in two (2) longitudinal directions along the cable runway.

F. Provide reinter able fire-stopping assembly/s for communications cable entrance/exit to/from each MDF/IDF. System shall be a UL approved system and shall have capacity for 125% of the installed cabling [Hilti CP653 Speed Sleeve or STI 44+ EZ-Path Series]. Provide all required mounting hardware and cable bend radius control as required for installation.

2.4 WALL MOUNTED CABINETS (TELECOMMUNICATIONS)

A. Wall mounted cabinets shall have the following properties; black powder coated, be a three-part design (i.e., the front door is hinged, the main body is hinged to a fixed wall mounted base), door and main body one-time configurable to swing from left or right side, front door and main body is secured via mechanical key lock, fixed base has knockouts for conduit entrance/exit, have adjustable depth 12-24 threaded 19-inch equipment mounting rails, 300 lb (min) load rating, 24-inches wide, 24-inch depth, and have a solid door [CPI CUBE-iT 11840-724 (24-inch height), 11840-736 (36-inch height), 11840-748 (48-inch height)].

1. Each cabinet shall be provided with the following accessories; 115 VAC 120 CFM low-noise fan and filter kit [CPI 40975-001], provide as required rear vertical premise cable strain relief lashing plate/s [CPI 40971-724 (24-inch height), 40971-736 (36-inch height), 40971-748 (48-inch height)], and provide as required black vertical cable management sections for patch cable management [CPI 40970-704 (4 rack mount unit), 40970-707 (7 rack mount unit), 40970-711 (11 rack mount unit)].

B. Cabinet shall be securely bolted to a ¾" fire resistant plywood backboard at a minimum of six (6) points.

1. Plywood backboard shall be painted on all six (6) sides with light-colored fire-resistant paint. Coordinate paint color with Architect.
2. Plywood backboard shall be secured to all wall studs, in which it covers, at 18-inch intervals (min) along each stud.

C. Outside of a dedicated MDF/IDF Room, EMT conduit shall be installed from the cabinet's fixed base to accessible ceiling for communications cabling entrance/exit. Conduit size shall be 3-inch diameter (min) in quantities necessary for installed cabling plus one (1) future conduit of the same size.

2.5 TELECOMMUNICATIONS SPACE GROUNDING AND BONDING

A. All equipment racks/cabinets shall be grounded to the local telecommunications grounding busbar as follows:

1. For telecommunications spaces with a single rack or wall mounted cabinet, ground rack/cabinet frame to grounding busbar via a green insulated # 6 AWG (min) stranded copper conductor terminated via 2-hole, irreversible crimped lugs.
2. For telecommunications spaces with multiple racks/cabinets provide a single green insulated # 2/0 AWG (min) stranded copper conductor (i.e., TEBC) from the PBB/SBB to, and along, each row of racks/cabinets. At the busbar, terminate this conductor via a 2-hole, irreversible crimped lug. Bond each rack/cabinet to the TEBC with a green insulated # 6 AWG (min) stranded copper conductor (i.e., RBC). Terminate the RBC to each rack/cabinet via 2-hole, irreversible crimped lug. Terminate the RBC to the TEBC via an irreversible crimped HTAP and insulating cover.

B. All spliced cable runway sections and/or adjacent non-spliced runway sections shall be electrically bonded together via # 6 AWG stranded bonding straps [CPI 40164-001]. All paint shall be thoroughly removed at bonding strap lug locations. The cable runway structure shall be grounded to the local telecommunications grounding busbar via a green insulated # 6 AWG (min) stranded copper conductor terminated via 2-hole, irreversible crimped lugs.

C. Bond all intra-building metallic cable armor, strength members, and/or shields to a proper telecommunications ground.

D. Bond all inter-building (i.e. outside plant) metallic cable armor, strength members, and/or shields directly to the telecommunications grounding busbar with a green sheath # 8 AWG (min), stranded copper conductor.

E. Bond all lightening/surge protection equipment directly to the telecommunications grounding busbar via a green insulated # 6 AWG (min) stranded copper conductor terminated via 2-hole, irreversible crimped lugs.

2.6 TELECOMMUNICATIONS SPACE EQUIPMENT

A. Uninterruptible Power Supplies

1. APC Smart UPS, Line Interactive, 2200VA, 2 RMU, 120V, 5-20P input, (6) 5-15R & (2) 5-20R NEMA outlets (APC SMT2200RM2UC).
    a. Two (2) UPS required for each chassis network switch (Redundant “A” & “B” power).
2. APC Smart UPS, On-Line, 3000VA, 2 RMU, 208V, L6-20P input, (2) L6-20R & (1) L6-30R NEMA outlets, with rail kit (APC SRT3000RMXLTUS).
    a. Two (2) UPS required for each chassis network switch (Redundant “A” & “B” power).
3. APC two post rail kit for Smart UPS (APC AP9625)

B. Power Distribution Units (Power Strips)

1. 19” horizontal rack mount, 1 RMU, metered, surge-protected, 120V, 5-20P input, (12) 5-20R NEMA outlets (Chatsworth 13239-757). Used with 2200VA, 120V UPS’.

2.7 INTRABUILDING (OSP) BACKBONE CABLING

A. Refer to the drawings for specifics as to interbuilding (i.e., outside plant) fiber strand or copper pair count.

B. Fiber optic cabling shall be OS2 single-mode, outside plant, 250µm buffered loose-tube, dry water blocking design, UV resistant cable sheath, and have all dielectric construction [Corning Cable Systems 012EU4-T4701-D20 (12-strand), 024EU4-T4701-D20 (24-strand)].

C. It is desirable to have multiple cables installed within a single fabric innerduct cell to maintain maximum conduit/innerduct fill capacity. When multiple cables are installed in a single innerduct they must be installed/pulled at the same time. Only “like” cable types (e.g., fiber, multi-pair copper) shall be installed in a single innerduct.

D. Contractor shall provide service loops, for each cable type, as follows:

1. At each MDF/IDF there shall be a 10-foot service loop.
2. Provide two (2) loops around the perimeter of each manhole/handhole.

2.8 INTRABUILDING BACKBONE CABLING TERMINATION

A. Each fiber strand shall be terminated via a OS2 single-mode, 900µm LC to pigtail, 1 meter fusion cable assembly [Panduit F91BN1NNNSNM001].

1. Splices shall be housed in a 24-strand splice module [Panduit FOSMF].
2. Splice modules shall be installed/mounted in a rack mounted FDC. FDCs shall be sized for 25% fiber growth, have cable entry grommets, bend radius control, cable management and metallic main structure [Panduit Opticom FRME1U (3 bulkheads), FRME2U (6 bulkheads).
    a. Install FDC/s beneath a 2 RMU horizontal wire manager mounted at the top of the rack.
        1) The MDF shall have a 2 RMU FDC (minimum size), unless indicated otherwise in the drawing set for small facilities.
        2) Wide Area Network fiber (i.e., building service fiber) shall be terminated in a separate FDC.
        3) IDF shall utilize a 1 RMU FDC.
    b. Fiber connectors shall be installed in 24-strand, 12-duplex LC, single-mode zirconia split sleeve blue adapter bulkheads [Panduit Opticom FAP12WBUDLCZ].
    c. Each unused FDC bulkhead position shall have a blank insert installed [Panduit FAPB].
    d. Dust caps shall be installed on all adapter/fiber ports.
    e. All FDCs shall bear a warning label similar to the following: "*CAUTION - Never look into the end of a fiber optic cable or connector or permanent eye damage can occur. When distribution center is open wear appropriate eye protection"*.

B. Every two (2) fiber connector pairs (i.e. duplex connection) must be flipped to maintain transmit/receive polarity throughout the channel.

C. Contractor shall provide all applicable materials, labor, and equipment for fiber termination. These items may include, but are not limited to, connectors, splice trays, mounting brackets, adapter panels, bulkheads, consumables, and fusion splicers. Installation shall follow manufacturer recommended procedures and instructions.

2.9 POWERED FIBER CABLING SYSTEM

A. Provide a powered cabling solution that combines power and fiber in one cable sheath. System shall be capable of providing PoE connectivity at the edge (beyond 2,000-feet) to be used for outdoor pole mounted cameras. Confirm PoE power requirements for each camera location and provide the necessary powered fiber solution components.

B. Provide all components from patch cable/cord to patch cable/cord for a complete system.

C. Provide surge protection for power transmission lines at both the MDF/IDF and remote end, 48vdc service voltage, 20,000a surge current, 5a continuous current, differential and common mode protection (Ditek DTK-2MHLP48BWB). All components (e.g., remote, surge protection, etc.) must be properly bonded to an earth ground.

1. Within the MDF/IDF, split the powered cable fiber optic assembly sheath and separate power from fiber.
2. Terminate power conductors to a surge protection device mounted on the wall backboard. Extend power conductors from the surge protection device to the headend power supply module.
3. Extend the pre-terminated fiber optic cable from the backboard to the headend equipment media modules.
4. Protect fiber optic cabling and power transmission conductors between the backboard and media modules with an appropriate solution such as innerduct.

D. Provide outdoor rated patch cables for use at the edge device.

E. All outdoor cabling and connections shall be protected from the environment.

F. Headend equipment

1. Rack mount chassis, 6-slot, 2 RMU (Leviton 81001531)
2. Power supply, 250w, 56vdc (Leviton 81001536)
3. Media module, 4-port, 10/100/1000Base-T, RJ45, single-mode, four (4) duplex LC (Leviton 81001262)
4. Rack mount chassis, blanking panel (Leviton 81000190)

G. Powered fiber optic cable assemblies.

1. Preterminated LC to LC powered fiber optic cable assembly, 4-strand (2-connections max), OS2 single-mode, loose-tube indoor/outdoor riser rated, #12 AWG 2-conductor power fiber optic cable assembly (Leviton BACR04A02D44FFNNPxxxx, where “xxxx” is the length in feet).
2. M8 pigtail cable assembly, 4-conductor, 36-inch length, required at all 1-port, 2-port, or 4-port remotes (Leviton 11099453).

H. Remote PoE ports

1. Remote PoE port, 1-port, 10/100/1000Base-T, RJ45, single-mode, one (1) duplex LC port, M8 power input connection, (Leviton 81001513). Each pole mounted camera shall utilize a single 1-port remote.

2.10 HORIZONTAL CABLING

A. All horizontal cabling shall be category 6A.

B. All interior category 6A cabling shall be 100 Ω, 23 AWG 4-pair (8-wire), UTP, 500 MHz with a plenum jacket. All related cable terminations and devices shall meet or exceed Category 6A standards.

1. [Panduit PUP6AHD04xx-G, where “xx” is the sheath color].

C. All category 6A cabling which is installed in below slab/grade pathway, shall be 100 Ω, 23 AWG 4-pair (8-wire), UTP, 500 MHz with a indoor/outdoor plenum jacket.

1. [Panduit PUO6AS04xx-G, where “xx” is the sheath color].

D. Category 6A cables shall have the following sheath colors:

1. Red – Analog Voice [“xx” color is RD]
2. Blue – Data, VoIP Voice [“xx” color is BU]
3. Green – WAP [“xx” color is GR]
4. Violet – Printers, Copiers, Security [“xx” color is VL]
5. Gray – Speakers [“xx” color is IG]
6. Black –Substitute for below slab/grade links, only when required sheath color (see above) is not available from the manufacturer [“xx” is BL]. Confirm color with Owner prior to procurement and installation.

E. Category 6A cabling installed to an outside plant location such as a utility pole camera or utility pole/bollard wireless access point location must be rated for the environment it is installed in.

1. The portion of the cabling link outside of the building footprint or within subterranean pathway must be gel-filled outside plant rated with a black sheath [Superior Essex 04-001-A4 (category 6A)].
2. The cable link shall have a SPD at the edge device location. This shall be accomplished via a UL497 rated, 110/RJ45 style termination, category 6A, 4-pair ethernet SPD [Ditek DTK-110RJC6APOE].
3. At the point within the building where the outside plant cabling shows itself (i.e., the outside plant conduit terminates), the cable shall be terminated on a UL497 rated, 110-in/110-out style termination, category 6A, 4-pair ethernet SPD [Ditek DTK-110C6APOE]. If this point is not within the MDF/IDF the

SPD shall be installed in a NEMA 1 enclosure, otherwise it shall be mounted on the MDF/IDF plywood backboard. From the SPD to the MDF/IDF termination field the cabling shall match the intrabuilding cabling criteria.

4. All SPDs shall be properly grounded to a local ground with an insulated 14 AWG, stranded copper conductor.

F. Legacy installation practices of tightly routed and bundled cable groups is prohibited. Limit cable group bundles to 24-cables (max).

1. Cabling within basket trays above the ceiling plane shall be left unbundled.
2. A maximum of 24-cables shall be installed within a single j-hook support. Cabling groups from j-hook to j-hook shall be loosely bundled with plenum rated hook & loop straps. Droop between j-hooks shall vary. Use additional j-hooks for pathways of more than 24-cables. J-hooks may share the same support (e.g., all-thread).
3. Within the MDF/IDF cabling shall be installed in a cosmetically neat fashion. Cabling shall be dressed, but loosely bundled and/or secured to cable runway with hook & loop straps. Use the most direct routing to the termination field.
4. Nylon or metal tie wraps are not allowed on any Category 6A cable or cable bundle.

2.11 PATHWAYS AND FIRESTOPPING

A. See Section 27 05 28.

2.12 HORIZONTAL CABLING MDF/IDF TERMINATION

A. Each horizontal category 6A shall be terminated via an UTP modular jack insert meeting the performance of the cabling to which it's terminated on. Modular jacks shall have the following properties; 22 – 26 AWG conductor insulation displacement contact cable termination design, which is color coded for both T568A/B pinout, color-coded, 8-position RJ45 female connection which can accept both 6 & 8 pin male modular plugs without damage.

B. Modular jack inserts at each horizontal cable link extremity.

1. Red – Analog Voice - category 6A jack module [Panduit Mini-Com CJ6X88TGRD]
2. Blue – Data, VoIP Voice - category 6A jack module [Panduit Mini-Com CJ6X88TGBU]
3. Green – WAP - category 6A jack module [Panduit Mini-Com CJ6X88TGGR]
4. Violet – Printers, Copiers, Security - category 6A jack module [Panduit Mini-Com CJ6X88TGVL]
5. Gray – Speakers - category 6A jack module [Panduit Mini-Com CJ6X88TGIG]

C. All jack inserts shall be placed in flat, 24-port (1 RMU) or 48-port (2 RMU), rack mounted, plastic label holder, modular patch panels [Panduit Min-Com CPPL24WBLY (24-port), CPPL48WBLY (48-port)].

1. Strain relief bars shall be installed and utilized behind each patch panel (Panduit SRB19BLY).
2. The Contractor shall group jack colors (i.e. red, blue, green, etc.) together on the patch panels for new projects. No spaces are required between jack colors.

D. Each unused patch panel module port shall be filled with black blank insert [Panduit Mini-Com CMBBL-X].

E. Horizontal wire management shall be 2 RMU, single-sided. [CPI Evolution 35441-702].

1. Horizontal wire managers shall be installed above and below all termination fields (i.e., fiber distribution centers, patch panels) for high density MDF/IDF (i.e., more than forty-eight horizontal cable segments). IDFs and/or wall mounted cabinets do not typically require horizontal wire managers above and below termination fields.
2. Coordinate additional wire managers with Owner for use around network equipment.

2.13 HORIZONTAL CABLING WAO AND EDGE TERMINATION

A. Each horizontal category 6A shall be terminated via a UTP modular jack insert meeting the performance of the cabling to which it's terminated on. Modular jacks shall have the following properties; 22 – 26 AWG conductor insulation displacement contact cable termination design, which is color coded for both T568A/B pinout, color-coded, 8-position RJ45 female connection which can accept both 6 & 8 pin male modular plugs without damage.

B. Modular jack inserts at each horizontal cable link extremity.

1. Red – Analog Voice - category 6A jack module [Panduit Mini-Com CJ6X88TGRD]
2. Blue – Data, VoIP Voice - category 6A jack module [Panduit Mini-Com CJ6X88TGBU]
3. Green – WAP - category 6A jack module [Panduit Mini-Com CJ6X88TGGR]
4. Violet – Printers, Copiers, Security - category 6A jack module [Panduit Mini-Com CJ6X88TGVL]
5. Gray – Speakers - category 6A jack module [Panduit Mini-Com CJ6X88TGIG]

C. All jack modules shall be installed in an appropriate faceplate, surface mount box, NEMA duplex frame, Decora frame, adapter bezel, etc. as required for the situation.

1. Color/s shall be coordinated with the Architect and will typically match the adjacent electrical device color. Verify colors prior to procuring such products.

D. Wall phone jack module shall be placed on a single-gang, stainless steel, phone plate with studs [Panduit KWPY].

1. Use an appropriate keystone modular jack insert for the wall phone faceplate.

   a. Red – Analog Voice - category 6A jack module [Panduit NetKey NK6X88MRD]
   b. Blue –VoIP Voice - category 6A jack module [Panduit NetKey NK6X88MBU]

E. Wall, gypsum ceiling, and/or metallic box mounted WAO and edge device WAO jack modules shall be installed in single-gang, stainless-steel, clear plastic label window faceplates.

1. 1 – 2 cable work area outlets shall utilize 2-port faceplate [Panduit Mini-Com CFPL2SY].
2. 3 – 4 cable work area outlets shall utilize 4-port faceplate [Panduit Mini-Com CFPL4SY].
3. 5 – 6 cable work area outlets shall utilize 6-port faceplate [Panduit Mini-Com CFPL6SY].

F. Modular furniture cabling shall be terminated in an appropriate faceplate for the modular furniture communications raceway cutouts. Faceplate shall be 4-port, non-metallic, with clear plastic window label holder [Panduit Mini-Com CFFPL4xx, where "xx" is the color].

1. Verify specified faceplate fitment to modular furniture manufacturer prior to procurement.
2. Coordinate faceplate color with Architect prior to procurement.
3. Provide non-metallic pass-through faceplate at the wall location for communications horizontal cabling as required. From the wall or floor device location, cover all communications horizontal cabling with split corrugated loom, of sufficient size to easily cover the cabling group, to the modular furniture communications cabling raceway entrance for both aesthetics and cable protection.

G. Edge device cabling jack inserts mounted in accessible lay-in acoustical ceilings (e.g., WAP, camera, etc.) shall be installed in 2-port, white, non-metallic, plenum surface mount box [Panduit Mini-Com CBX2WH-AY]. Surface box shall be secured to a # 12 AWG ceiling support wire, with an appropriate mounting bracket (Basis of Design Leviton 49223-CBC), not merely laying on ceiling tiles.

H. Blank jack inserts, matching in color to the faceplate, surface box, adapter bezel, etc., shall be installed in all unused jack module port positions [Panduit Mini-Com CMBxx-X where "xx" is the color]. Stainless steel faceplates shall utilize gray blank inserts when necessary [Panduit CMBIG-X].

I. For WAP locations in hazardous areas (e.g., gym), provide surface mounted enclosure. Enclosure shall have metallic backbone with non-metallic locking hinged cover/door [Oberon 1016-00].

1. Coordinate exact mounting height with Architect owner prior to installation.
2. Surface mount box for cable jack module termination shall be installed within the enclosure.

J. For WAP locations in outdoor locations, provide surface mounted bollard pedestal. The bollard shall be of fiberglass construction, tamper resistant, have beveled top, and be designed to protect wireless equipment in open public areas [Oberon 3030-00-xx where “xx” is the color].

1. Coordinate final location and color with Architect prior to installation.
2. Install per manufacturer instructions.

K. Where WAPs or cameras are mounted to the outside of a building perimeter wall, place the edge network outlet on the inside building perimeter wall at 12-inches (min) above the accessible ceiling in an accessible location.

2.14 MDF/IDF CROSS-CONNECT AND INTER-CONNECT CABLES

A. Prior to ordering copper patch cables, Contractor shall confirm final quantities, lengths, and colors with Owner.

1. Provide one (1) patch cable for each installed horizontal cable permanent link and powered fiber optic cable link. Note, powered fiber optic cable patch cables shall be violet in color.
2. The Contractor shall provide patch cables in appropriate lengths so that patch cable slack within the vertical/horizontal cable managers is minimized. Patch cable lengths will typically vary from 2 – 8 ft.

B. Copper patch cables shall match the jack insert color of the installed horizontal permanent link cabling.

C. Category 6A patch cables shall be 28 AWG, small diameter, stranded UTP, RJ45 to RJ45 [Panduit UTP28Xxxyy, where “xx” is the length in feet and “yy” is the color].

1. In low capacity IDFs or wall mount cabinets, network switches will be installed adjacent to patch panels and 8-inch patch cables shall be utilized (Panduit UTP28X8INyy, where “yy” is the color).

D. Category 6A patch cables shall have colored cable sheaths as follows:

1. Red (“yy” color is RD)
2. Blue (“yy” color is BU)
3. Green (“yy” color is GR)
4. Violet (“yy” color is VL)
5. Gray (“yy” color is IG)

E. Prior to ordering fiber patch cords, Contractor shall confirm final quantities and lengths with Owner.

1. Provide one (1) duplex fiber optic patch cord for every two (2) installed fiber optic strands at both the MDF and IDFs.
2. For the purpose of bidding, assume 50% of patch cables are 1-meter, 30% are 2-meter, and 20% are 3-meter in length.

F. Fiber patch cords shall match the performance of the installed backbone link.

G. Single-mode patch cords shall be duplex, 1.6mm, LC-connector to LC-connector [Panduit F92ER1N1NSNMxxx, where “xxx” is the length in meters].

H. Each type of fiber optic patch cord shall feature distinctively colored sheath colors:

1. Single-mode fiber patch cords shall be yellow.

I. The Contractor shall provide labor for the installation of patch cables and patch cords based on Owner provided cut-sheet.

2.15 WAO AND EDGE WORKSTATION PATCH CABLES

A. Prior to ordering copper patch cables, Contractor shall confirm final quantities, lengths, and colors with Owner.

1. Furnish one (1) patch cable for each installed horizontal cable permanent link.
2. For the purpose of bidding, assume 100% of horizontal copper channel patch cables are 10-foot.
3. Provide one (1) violet patch cable for each powered fiber optic remote PoE port at light pole locations. Patch cable shall be of sufficient length to connect the camera from the pole mounted enclosure.

B. Copper patch cables shall match the jack insert color of the installed horizontal permanent link cabling.

C. Category 6A patch cables shall be 26 AWG, stranded UTP, RJ45 to RJ45 [Panduit UTP6ASDxxyy, where “xx” is the length in feet, “yy” is the color)].

D. Category 6A patch cables shall have colored cable sheaths which match the color of the horizonal cable permanent link as follows:

1. Red (“yy” color is RD)
2. Blue (“yy” color is BU)
3. Green (“yy” color is GR)
4. Violet (“yy” color is VL)
5. Gray (“yy” color is IG)

E. The Contractor shall install all patch cable for equipment which is installed by the Contractor, such as phones, wireless access points, cameras, etc. The remainder of patch cables shall be furnished to the Owner for installation by the Owner for equipment such as printers, desktop computers, etc.

2.16 LABELING AND DOCUMENTATION

A. All structured cabling infrastructure shall be properly labeled with machine-generated labels. Labels be designed for the application. For example, self-laminating wrap-around labels of sufficient length for the cable diameter to which it is applied.

B. Labeling schemes shall be verified with Owner and approved prior to labeling and testing.

C. At minimum, the following must be properly labeled:

1. Equipment racks and cabinets
2. All installed cabling shall have self-laminating labels installed within 2-inches of sheath extremity.
3. All FDC doors/covers
4. All FDC bulkhead duplex adapter ports
5. All multi-pair 110 termination pairs (wall mounted 110 blocks and SPD)
6. All multi-pair RJ45 ports
7. All horizontal cable RJ45 ports
8. All MDF/IDF patch cable/cord sheath extremities

D. All labeling shall conform to industry standards and best practices.

E. Backbone cabling labeling scheme shall incorporate the drop designator and “far end” cable termination location.

F. Labeling shall also be provided on WAO and edge device locations which are located above an accessible ceiling location (e.g., WAP, camera, projector, etc.). Labels shall be affixed to the ceiling grid and have a font that is readable from standing below.

G. Equipment rack and cabinet labels shall be engraved on beveled side, ¾-inch height, adhesive backed, plastic black-on-white nameplates affixed to the top of racks and cabinets.

H. For each MDF/IDF provide a CAD generated floorplan depicting the MDF/IDF location, room names and numbers, all WAO/edge device locations served by the MDF/IDF, WAO/edge device location type and legend, WAO/edge device location identification, and drawing scale.

1. Each drawing shall be provided to Owner in both the native CAD electronic format (e.g., AutoCAD) and electronic pdf format.
2. For MDF/IDF drawing shall printed to E1-size and placed in a wall mounted clear acrylic cover holder.
3. For wall mounted cabinet locations drawing shall printed to C-size, laminated, rolled up and placed in the rear of the cabinet.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., cable shall not be supported by or lay on suspended ceilings). Fasteners and supports shall be adequate to support the required load.

B. The maximum horizontal cable permanent link length from MDF/IDF to the WAO or edge workstation termination shall be 295-foot. This maximum length is inclusive of vertical rise and falls and all service loops.

C. Category 6A service loops shall be installed in a figure-eight orientation as opposed to a simple circular loop. All loops shall not exceed the manufacturer's minimum bend radius. Provide service loops as follows:

1. At outside plant access points (e.g., maintenance holes, communications vaults, and handholes) provide a cable loop around the perimeter of the access point.
2. At each MDF/IDF provide a 10-foot (min) service loop for backbone cabling. Service loops shall be neatly stored in the accessible ceiling within or adjacent to the MDF/IDF, around the MDF/IDF cable runways, or on the plywood backboard given sufficient space.
3. At the MDF/IDF provide a 10-foot service loop. Service loops shall be neatly stored in the accessible ceiling within or adjacent to the MDF/IDF.
4. At all wall device locations provide a 10-foot service loop.
5. At all WAP locations, provide a 10-foot service loop.
6. At all security camera locations, provide a 10-foot service loop.
7. Service loops may be eliminated, only if cable permanent link distance will exceed 295-foot. If this is the case eliminate the WAO or edge location service loop first, before eliminating the MDF/IDF service loop.

D. All non-rated, outside plant cabling, shall be transitioned to plenum within 50-feet of showing within the building. Showing is defined as when the cable emerges from a under slab conduit or when it first emerges from a RMC/IMC conduit entering a building from outside.

E. Installation subject to approval, inspection, and test of the Architect/Engineer.

3.2 EQUIPMENT ROOM

A. All equipment racks/cabinets shall be installed level and plumb and secured to the floor or wall, at four (4) corners, with 3/8" (min) mechanical fasteners. Fasteners shall be cut and deburred as required to prevent harm to personnel and/or potential damage to cabling.

B. Vertical cable runs exceeding 12-inches within equipment closets shall require vertical cable runway. Attachment shall utilize appropriate mounting hardware and accessories for vertical placement and allow a minimum of 2" clearance between the wall and runway. Cable attachment shall be made by Velcro hook and loop straps.

3.3 CABLE ROUTING AND INSTALLATION

A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical code requirements.

B. The maximum fill capacity for any conduit shall not exceed 40%.

C. Prior to installing cabling within metallic conduit, confirm that all conduit extremities have bushings. Attempting to install bushings after cable installation is not acceptable and will require cable removal, bushing installation, and reinstallation of cabling.

D. All communications cabling shall be properly supported from the building structure in an appropriate pathway support system.

1. The support system shall provide a protective pathway to eliminate stress that could damage the cabling. The cable shall not be crushed, deformed, skinned, crimped, twisted, or formed into tight radius bends that could compromise the integrity of the cabling.
2. Communications cable must not be fastened to electrical conduits, mechanical ductwork/piping, water/sprinkler pipes, or routed to obstruct access to hatches, doors, utility access panels, or service work areas. Do not route cables through fire doors, ventilation shafts, grates, or parallel with line voltage electrical conductors. Communication cables shall not be run loose on ceiling grid or ceiling tiles.
3. Never install cabling and/or cabling pathway through building structures (e.g., structural steel webbing).
4. Never wrap cabling around a building structure or building system.

E. Outside of basket tray and/or conduit, cabling shall be loosely bundled with cable Velcro hook ties randomly spaced at 30 to 60-inches on center, hook and loop straps shall not be tight enough to deform cabling and shall not be used to support the cabling. Limit cable bundles to twenty-four (24) cables.

F. Communication cable shall not be installed in the same conduit, raceway, tray, duct, or track with line voltage electrical cable without a metallic barrier meeting NEC requirement.

G. Maximum cable pulling tension should not exceed 25-pounds force or the manufactures recommendation, whichever is less.

H. Any pulling compounds utilized must be thin film lubricants approved by the cable manufacturer and shall not degrade the strength or electrical characteristics of the cable.

I. All cabling is to be continuous without splices unless otherwise noted.

1. Absolutely no terminations or splices shall be installed in or above ceilings.

J. Cable bends shall not be tighter that the manufacturers' suggested bend radius.

K. Mount all equipment firmly in place. Route cable in a professional, neat and orderly installation.

L. If wiring is terminated prior to wall leveling, painting, carpet installation, or general finish clean up, these termination components shall be protected to ensure dust, debris, moisture, and other foreign material do not settle onto jack contacts.

1. Protection will be removed on final trim out after other trades have completed their finish work.
2. It shall be the Contractor's responsibility to ensure the integrity of these protective measures throughout the life/installation of the project.

M. Cable bundles brought into the communications rooms shall be routed and dressed in such a manner that prior to termination the cables are not subject to damage such as installers walking on the bundles that are on the floor.

1. Do not leave cables on the floor unprotected or cable bundles hanging from the ceilings. Coil them up in a temporary manner and protect them from damage.

N. Communications room cables shall be combed and dressed in a manner as to prevent twists, "braiding", and crossed cables in the cable bundle from the communication room entrance to the termination point.

1. Use velcro wraps instead of cables ties for all bundling in the communications rooms. Place wraps as equidistant intervals not to exceed 9-inches.
2. Plastic/nylon tie-wraps are not allowed to permanently secure/bundle cables inside the communications room.

O. Provide for adequate ventilation to all equipment racks and take precautions to prevent electromagnetic or electrostatic hum.

3.4 CATEGORY 6A CABLE TERMINATION PRACTICES

A. All category 6A cabling shall be terminated per the T568B pinout scheme.

B. Strip back only as much cable jacket as required to terminate.

C. Preserve wire-pair twists as closely as possible to point of termination (1/2-inch maximum) to keep signal impairment to a minimum.

D. Avoid twisting cable jacket during installation.

E. Score for removal approximately 3" of cable jacket using a manufacturer recommend stripping tool set to cut through the outer jacket.

F. Gently bend the cable's jacket back and forth to free it and remove that portion of the outer jacket.

G. Snip the end of the suppression barrier tape, split it, fold it down and trim it even with the outer jacket.

H. Bend back the four pairs and cut the center spline. It is not necessary to provide a completely flush cut as attempting to do so may damage the conductors.

I. Trim the pairs to length per the per the manufacturers' recommendations.

J. Without untwisting or rearranging the pairs, feed each pair into the correct opening in the jack stuffer housing.

K. Push the cable fully into the jack stuffer housing.

L. Trim the pair ends of with the manufactures' recommended trimming tool.

M. Loosen the pair twists only enough to seat the conductors into the color-coded IDC slots.

N. Snip off the conductor ends flush with the jack stuffer housing.

O. Insert the stuffer housing into the jack outer housing and clamp them tight using the manufacturers recommended termination tool.

P. Once the other end of the cable is terminated, test the cable from end to end with a cable tester. Be sure that all eight conductors have proper connection.

3.5 OPTICAL FIBER CABLE INSTALLATION AND TERMINATION PRACTICES

A. During installation of optical fiber cable, do not allow pulling tension to exceed cable manufacturers' specification for the cable being installed. Only the strength member of the cable shall be subjected to the pulling tension.

B. Follow the manufacturers recommended termination methods and instructions for fiber optic installation.

1. Furcate all fiber to 900µm (min) as required using an appropriate furcation/break-out kit.
2. Terminate all installed fiber strands unless noted otherwise.

C. During optical fiber connector termination, visually inspect all terminations with a 200-power (min) microscope. Follow all of the connector manufacturers' recommendations. Unacceptable flaws in the terminations will include, but not be limited to, scratches, full or partial cracks, bubbles, pits, or residual dirt, dust, oil, moisture, grinding or sanding debris in the connector. The acceptable final inspection shall show a connector tip that is properly aligned and free of imperfections in 100% of the core and 80% of the cladding. Any connectors that fail testing shall be inspected and re-tested after rework.

D. Clean all optical fiber connector tips prior to inserting them into mating receptacles or bulkheads and re-install dust covers. Clean the tester launch cord prior to each insertion, as well.

3.6 WARRANTY, SERVICE, TESTING, CERTIFICATION

A. Any equipment or cabling shown to be defective shall be replaced, repaired, or adjusted free of charge. All labor and materials shall be provided at no expense to the Owner.

3.7 UTP CABLE AND LINK TESTING

A. The Contractor shall make a thorough inspection of the complete installation to ensure the following:

1. Complete and functional system.
2. Installed in accordance with manufacturers' instructions.
3. All cabling shall test free from all grounds, opens, and shorts.
4. A representative of the Owner may be present for all final testing. Coordinate final testing with Owner, schedule as near as possible to acceptance date.

B. Acceptance Testing: Test each conductor of every cable on the reel to verify length and continuity. Cables that have been damaged in transit must be replaced. Installed cable that proves to be defective will be replaced at the Contractor's expense.

C. Final Testing: All Category 6/6A cabling will be certified to meet and or exceed the specifications asset forth for Permanent Link Testing. Testing shall meet TIA/EIA compliant standards appropriate for each device type including:

1. Category 3 and 5e per TIA/EIA-568B / TIA Category 5 (1000BASE-T) per TIA TSB-95 / TIA.
2. Category 6-CLASS E/D Permanent Link Testing per TIA TSB-67 / TIA.
3. Category 6A/Class E_A per TIA/EIA-568B.2-10 / TIA TSB-155 / ISO/IEC 11801 Class C, D, and E / ISO/IEC 11801 Class E_A, F / EN 50173 Class C, D, E / EN 50173 Class F / ANSI TP-PMD; Networking Standards: IEEE 802.3 / I.

D. Test alien crosstalk (near-end and far-end loss) for a cabling system using a network analyzer as follows:

1. Frequency range from 1 to 500 MHz (250 MHz for Category 6).
2. The test device consists of two jacks; one jack is connected to a main test unit and the other to a remote test unit; the main test unit and the remote test unit are connected with a field tester communication channel (patch cord or link).
3. Modeling four-connector channel configurations using the worst-case maximum and minimum configurations to determine the worst-case for different parameters.
4. Long channels with 90 meters of permanent link, 5 meters between the consolidation point and the telecommunications outlet, 10 meters of patch cords used to connect active equipment and cross-connect panels.
5. Measurement of alien crosstalk (near-end and far-end loss) between all pairs of the middle disturbed cable and each pair of all adjacent cables.
6. Measurement of power sum of all 24 adjacent pair cables.

E. The cable tester shall a UL Level III tester or equivalent with the latest version of firmware and shall produce a printed report, noting label information, for each cable run. These reports are to be included in the close-out documentation. Testing shall be conducted with a Fluke, or equivalent, copper/fiber/OTDR cable analyzer with DTX 10 Gig kit including alien crosstalk communication modules, permanent link adapters, high-performance channel adapters, termination plugs, 8-pin modular couplers and analysis software. Certifications shall include the following parameters from up to 1 to 500 MHz for each pair of each cable installed:

1. Characteristic Impedance 100 Ω +/- 15%
2. Wire map (pin to pin and ground connectivity)
3. Cable Length Permanent Link, station (horizontal) cable from patch panel to jack, should not exceed 295 feet (Channel length not to exceed 328 feet).
4. Attenuation
5. Pair to pair NEXT
6. PSNEXT
7. FEXT (Far end crosstalk)
8. Pair to pair ELFEXT (Equal level far end crosstalk)
9. PSELFEXT
10. Return Loss
11. PSACR
12. Propagation Delay
13. Delay Skew
14. Alien Crosstalk

F. The cable shall not be disturbed for any reason after successful final testing.

3.8 OPTICAL FIBER TESTING

A. Conduct spool fiber testing, as described in Part 3, for all requirements shall be performed on all cable spools before installation.

B. Conduct final testing, as described in Part 3, for all requirements shall be performed with all labeling, cable, supports, wiring devices, and connectors in place. The cable shall not be disturbed for any reason after successful final testing. A certification report shall be provided for each cable run.

C. Acceptance Testing: Test each strand of every optical fiber cable on the reel with an OTDR, to verify length and continuity. Fiber cables that have been damaged in transit must be replaced. Installed fiber cable that proves to be defective will be replaced at the contractor's expense.

D. Final Testing: After termination each individual fiber of each cable segment shall be tested using an OTDR, both to determine the installed length and continuity. All individual fibers of each cable segment will be tested using a power meter to determine the actual loss. These readings will be taken at the 850 nm and 1300 nm windows for Multimode and 1310 nm and 1550 nm windows for single-mode. Testing will be in both directions. The final readings shall be listed in the certification report. These readings must not be higher than the "Optimal Attenuation Loss." The OAL will be calculated using the manufacturers' factory certified test results, (dB/Km) converted to the actual installed lengths plus the manufacturers' best published attenuation losses for the connector and/or splice installed on this project. (0.20 for Connectors and 0.10 for splices.) The OAL shall be used for comparison with the end to end power loss test results prior to acceptance by the construction manager.

E. Fiber optic cable shall be subjected to bi-directional testing meeting EIA/TIA 568B, Section B.3, testing recommendations. The cable tester shall produce a printed report, noting label information, for each cable run. These reports are to be included in the close-out documentation.

3.9 DRAWINGS, MANUALS, AND TRAINING

A. As-built drawings and operating and maintenance manuals may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.

B. Upon completion of the installation, and prior to final inspection, the Contractor shall furnish as-built drawings.

C. In addition, the contractor shall furnish complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets. Manuals shall include wiring diagrams to indicate internal wiring for each device and the interconnections between the items of equipment. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system. Provide a parts list with manufacturer and model number for commonly replaced parts. Include complete instructions for the inspection, testing, and maintenance of the system. Place final cable certification test results in manuals.

D. All cable paths and wiring methodology shall be documented. All cables shall have both ends labeled and included in the as-built documentation. Provide an MS Excel worksheet compatible format spreadsheet file cross referencing all cable run numbers, architectural room number, and owners room number for the origin and destination of each cable run.

E. A formal on-site training session shall be provided by the Contractor to the Owners Representative / Maintenance personnel and shall include instruction on the documentation, location, inspection, maintenance, testing, and operation of all system components. Provide a minimum of two (2) hours of documented general instruction.

END OF SECTION

SECTION 27 20 00

DATA COMMUNICATIONS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, labor, equipment, and extended service plans as called out in the Contract Documents.

B. This section includes the specifications for the active data network equipment and integration services required to support the new facility.

C. All equipment shall be purchased under the Eagle Mountain/Saginaw ISD name for warranty and operations and maintenance 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 or the Drawing Set:

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. ISD Independent School District
8. LAN Local Area Network
9. MDF Main Distribution Frame
10. NEMA National Electrical Manufacturers Association.
11. PoE Power over Ethernet
12. SCS Structured Cabling System
13. SFP Small Form Factor Pluggable
14. TIA Telecommunications Industry Association
15. UL Underwriters Laboratories
16. VoIP Voice Over Internet Protocol
17. WAN Wide Area Network
18. WAP Wireless Access Point
19. WLAN Wireless Local Area Network

1.3 QUALITY ASSURANCE

A. All equipment shall be installed in a neat and high quality workmanship manner.

B. All tasks which are not specifically described or called out in the Contract Documents shall be subject to control and approval of the Owner.

C. 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.

D. Contractor 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 may be checked, and the clients may 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. 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.

G. 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 RELATED SECTIONS

A. Related work specified in other sections

1. Section 27 05 00 – Common Work Results for Communications
2. Section 27 05 26 – Grounding and Bonding for Communication
3. Section 27 05 28 – Pathways for Communications Systems
4. Section 27 10 10 – Voice and Data Cabling Distribution System
5. Section 27 30 00 – Voice Communications Equipment

1.9 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Provide all submittal requirements under this section in a single submittal package.

D. Provide product data for each type of product. This list is not inclusive of all required product data.

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.

E. Product data submittal requirements:

1. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting Sub-Contractor.
2. Include on or after the cover sheet sufficient space for review stamps.
3. Provide a product data index and complete material/equipment list for each product submitted.
4. For any deviations from the Contract Document requirements, including variations and/or limitations, provide descriptions of such. Show any revisions to equipment layout required by use of selected equipment.
5. Provide cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by **prominent** notation (e.g., an arrow, box, circle, or other means) on each sheet the exact product and options being submitted.
6. For each product identify the manufacturers name, part number, and selected options and colors.
7. Submit design data, when the scope of work requires such, including calculations, schematics, risers, sequences, or other data.
8. Submit a sample of the extended product warranty language.

F. Any resubmittal shall include a complete revised material/equipment list along with revised product data.

G. Provide floor plan Shop Drawings, in pdf electronic format, indicating:

1. Locations of all network equipment.
2. Equipment rack elevations.
3. One-line diagrams showing network connectivity and fiber links assigned.

H. Submit a complete submittal package within thirty (30) calendar days after award of this work for approval.

1. Materials or equipment shall not to be ordered without written approval.
2. Partial submittals are not acceptable for review.
3. Each submittal shall include a dated transmittal.

I. Submittal/s shall be electronically transmitted in pdf electronic file format (preferred).

1. Paper copies may be provided in quantities indicated in Division 01.
2. Paper copies shall be organized including index tabs in an appropriately sized 3-ring binder.

1.10 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements.

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 horizontal cable assignments.
5. As built documentation of MDF/IDF modifications and associated rack elevations.

B. Warranty and Maintenance:

1. Documentation shipped with equipment.
2. Record Drawings

1.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in containers in manufacturer/factory packaging. Store materials in a clean and dry space and protect products from damage. Handle materials in accordance with manufacturer's recommendations to avoid damage.

B. Material storage space on the project site may be limited. The Contractor shall coordinate delivery and arrange storage of materials and equipment with the Owner. Contractor may need to allow for material storage in a Contractor provided storage container.

C. The Contractor shall be responsible for on-site security of materials, tools, and test equipment.

D. The Contractor shall provide protective coverings, as required during construction, to prevent damage to installed components.

E. At no expense to the Owner, the Contractor shall replace components/materials damaged during storage, handling, or installation throughout the construction duration.

1.2 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.

1.3 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. Unless noted otherwise, the contractor is responsible for providing any/all other equipment, components, and materials needed to deliver a complete and working system.

2.2 NETWORK SWITCHES

A. Network equipment shall utilize structured cabling backbone (Section 27 10 10).

B. Contractor shall provide a turnkey local area network (LAN) equipment solution/installation and/or expansion to Owner's existing equipment in the Administration Building and Marine Creek Middle School, less configuration, as required to support all ethernet requirements within the new Arena/Barn Buildings. Final network configuration shall be done by Owner.

C. Provide sufficient network switches and switch modules to patch all installed horizontal cabling 100%.

1. Stackable 1-RMU, 48-port switches are typically used for wall mounted cabinets and racks with up to forty-eight (48) horizontal cable segments.
2. Larger chassis style switches are used for racks containing more than forty-eight (48) horizontal cable segments and all MDFs.

D. Provide all required network equipment [e.g., switches, management cards, power supplies (redundant for chassis switches), power cables, 48-port PoE copper cards, stacking cables, direct attached cables, fiber/copper transceiver modules, management tool subscription license, etc.] for a complete local area network system.

E. The new Arena Building campus [consisting of two technology rooms (MDF & IDF)] local area network will be connected to an existing district local area network in two (2) nearby building MDF rooms.

1. These connected buildings are the Administration Building and Marine Creek Middle School.
2. Contractor shall provide all necessary equipment and labor to connect to existing equipment within these buildings.

F. General:

1. Contractor shall confirm exact make, model, configuration and accessories with Owner prior to placing order.
2. Contractor shall request and utilize Owner approved reseller for procurement.
3. Contractor shall provide all required subscriptions/licenses for the Aruba Central's cloud based network management tools for a period of 3-years. Details shall be provided to Owner for ongoing subscription/license charges.

G. Non-inclusive equipment list:

1. Aruba JL659A 6300M, L3 Managed, PoE+, 48-port, 1 RMU switch
2. Aruba R0X26C CX 6405 v2 Switch, L3 Managed, rack mount, front to back airflow
3. Aruba R0X27C 6410 v2 Switch, L3 Managed, PoE+
4. Aruba R0X35A#ABA 1800 watt, hot-plug power supply, with IEC C16 inlet connector
5. Aruba R0X31A 6400 management module
6. Aruba R0X39C 6400, 48-port, 10/100/1000, Class 4 (25.5w) PoE and 4-port SFP56 v2 module
7. Aruba R0X40C 6400, 48-port, 10/100/1000, Class 6 (51w) PoE and 4-port SFP56 v2 module
8. Aruba R0X41C 6400, 48-port, 1/2.5/5GbE, Class 6 (51w) PoE and 4-port SFP56 v2 module.
9. Aruba J9151E SFP+ transceiver module, 10GbE, 10GBase-LR (up to 6.2 miles), LC Single-Mode.
10. Aruba Q9G82A QSFP+ transceiver module, 40GbE, 40GBase-ER4 (up to 24.9 miles), LC Single-Mode
11. Aruba R8L81AAE 3-year Central Foundation Subscription license for single 6400 series switch

2.3 WIRELESS NETWORK EQUIPMENT

A. Provide wireless access point equipment for wireless access point locations indicated on the technology drawings.

B. Access points shall comply with IEEE WLAN standards:

1. IEEE 802.11a/b/g/n/ac/ax

C. Access point shall support the following security standards:

a. WPA
b. WPA2
c. WPA3

D. Access point shall be capable of operating in the 2.4GHz, 5GHz, and 6GHz bands.

E. Access point shall be powered using Power over Ethernet.

F. General:

1. Contractor shall confirm exact make, model, configuration and accessories with Owner prior to placing order.
2. Contractor shall request and utilize Owner approved reseller for procurement.
3. Contractor shall provide required edge accessories (e.g., antenna, mounting brackets, etc.), as required, for a complete operational system.
4. Contractor shall provide all required subscriptions/licenses for Aruba Central's cloud based network management tools for a period of 5-years. Details shall be provided to Owner for ongoing subscription/license charges.

G. Non-inclusive equipment list:

1. Aruba R7J28A AP-635 internal antenna wireless access point
2. Aruba S1G50A AP-634 external antenna wireless access point (for wall mounted access point use in large areas such as Gyms/Cafeterias/Courtyards/Arenas)
3. Aruba S1F83A AP-ANT-345 tri-band 4x4 medium gain directional external antenna
4. Aruba R3J15A AP-MNT-A Type A mounting bracket for 9/16" T-beam ceiling grids
5. Aruba R3J16A AP-MNT-B Type B mounting bracket for 15/16" T-beam ceiling grids
6. Aruba R3J17A AP-MNT-C Type C mounting bracket for Interlude or Silhouette 9/16" T-beam ceiling grids
7. Aruba R3J18A AP-MNT-D Type D mounting bracket for flat surfaces
8. Aruba R3J19A AP-MNT-E Type E mounting bracket for standard wall device boxes
9. Aruba S1J09A AP-ANT-MNT-U external wireless access point antenna articulating wall mount kit
10. Aruba Q9Y60AAE 5-year Central Foundation Subscription license for single wireless access point

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify rack grounding and bonding (Section 27 05 26).

B. Verify the appropriate circuit and uninterruptible power supply power circuit voltage, amperage and plug types were provided by the Division 26 and 27 contractors.

C. Where appropriate, verify the equipment cabinets include the appropriate air circulation baffles.

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, 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 racks and/or cabinets are properly mounted/secured.

C. Ensure that a temperature between 65°F – 78°F and between 30% - 50% humidity is maintained in areas of data equipment.

3.4 INSTALLATION

A. Install equipment following drawings, manufacturer's instructions, and approved submittal data.

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 shared system equipment Vendors.

D. The Contractor will be responsible for making all necessary fiber optic patch cord cross-connects for MDF/IDF network equipment unless noted otherwise herein.

1. Fiber optic patch cords are provided under Section 27 10 10.
2. Copper patch cables are provided under Section 27 10 10. Copper network switch interconnect cables shall be installed by the Section 27 10 10 SCS Contractor. Coordinate switch installation with the SCS Contractor.
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 Section 27 10 10 SCS Contractor will mount and connect WAPs. Coordinate switch installation with the SCS Contractor.

F. The Owner shall be informed and will require a system inspection prior to the powering up of any equipment.

END OF SECTION

SECTION 27 30 00

VOICE COMMUNICATIONS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, labor, equipment, and extended service plans as called out in the Contract Documents.

B. This section includes the specifications for the VoIP (voice over internet protocol) equipment and integration services required to support the new facility.

C. All equipment shall be purchased under the Eagle Mountain/Saginaw ISD name for warranty and operations and maintenance 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 or the Drawing Set:

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.	ISD	Independent School District
8.	LAN	Local Area Network
9.	MDF	Main Distribution Frame
10.	NEMA	National Electrical Manufacturers Association.
11.	PoE	Power over Ethernet
12.	SCS	Structured Cabling System
13.	SFP	Small Form Factor Pluggable
14.	TIA	Telecommunications Industry Association
15.	UL	Underwriters Laboratories
16.	VoIP	Voice Over Internet Protocol
17.	WAN	Wide Area Network
18.	WAP	Wireless Access Point
19.	WLAN	Wireless Local Area Network

1.3 QUALITY ASSURANCE

A. All equipment shall be installed in a neat and high quality workmanship manner.

B. All tasks which are not specifically described or called out in the Contract Documents shall be subject to control and approval of the Owner.

C. 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.

D. Contractor Qualifications:

1. Firms regularly engaged in the installation of VoIP 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 may be checked, and the clients may 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 Avaya 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. 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.

G. 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 RELATED SECTIONS

A. Related work specified in other sections

1. Section 27 05 00 – Common Work Results for Communications
2. Section 27 05 26 – Grounding and Bonding for Communication
3. Section 27 05 28 – Pathways for Communications Systems
4. Section 27 10 10 – Voice and Data Cabling Distribution System
5. Section 27 20 00 – Data Communications Equipment

1.9 SUBMITTALS

A. Comply with provisions of Division 01.

B. Comply with provisions of Section 27 05 00.

C. Provide all submittal requirements under this section in a single submittal package.

D. Provide product data for each type of product. This list is not inclusive of all required product data.

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.

E. Product data submittal requirements:

1. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting Sub-Contractor.
2. Include on or after the cover sheet sufficient space for review stamps.
3. Provide a product data index and complete material/equipment list for each product submitted.
4. For any deviations from the Contract Document requirements, including variations and/or limitations, provide descriptions of such. Show any revisions to equipment layout required by use of selected equipment.
5. Provide cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by **prominent** notation (e.g., an arrow, box, circle, or other means) on each sheet the exact product and options being submitted.
6. For each product identify the manufacturers name, part number, and selected options and colors.
7. Submit design data, when the scope of work requires such, including calculations, schematics, risers, sequences, or other data.
8. Submit a sample of the extended product warranty language.

F. Any resubmittal shall include a complete revised material/equipment list along with revised product data.

G. Provide floor plan Shop Drawings, in pdf electronic format, indicating:

1. Locations of all VoIP equipment, including handsets.
2. Equipment rack elevations.
3. One-line diagrams showing network connectivity and fiber links assigned.

H. Submit a complete submittal package within thirty (30) calendar days after award of this work for approval.

1. Materials or equipment shall not to be ordered without written approval.
2. Partial submittals are not acceptable for review.
3. Each submittal shall include a dated transmittal.

I. Submittal/s shall be electronically transmitted in pdf electronic file format (preferred).

1. Paper copies may be provided in quantities indicated in Division 01.
2. Paper copies shall be organized including index tabs in an appropriately sized 3-ring binder.

1.10 CONTRACTOR CLOSE OUT SUBMITTALS

A. Submit Closeout documentation in accordance with Division 01 of the Project Manual and any applicable supplements.

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 horizontal cable assignments.
4. As built documentation of MDF/IDF modifications and associated rack elevations.

B. Warranty and Maintenance:

1. Documentation shipped with equipment.
2. Record Drawings

1.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in containers in manufacturer/factory packaging. Store materials in a clean and dry space and protect products from damage. Handle materials in accordance with manufacturer's recommendations to avoid damage.

B. Material storage space on the project site may be limited. The Contractor shall coordinate delivery and arrange storage of materials and equipment with the Owner. Contractor may need to allow for material storage in a Contractor provided storage container.

C. The Contractor shall be responsible for on-site security of materials, tools, and test equipment.

D. The Contractor shall provide protective coverings, as required during construction, to prevent damage to installed components.

E. At no expense to the Owner, the Contractor shall replace components/materials damaged during storage, handling, or installation throughout the construction duration.

1.2 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.

1.3 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. Unless noted otherwise, the contractor is responsible for providing any/all other equipment, components, and materials needed to deliver a complete and working system.

2.2 VoIP TELEPHONE SYSTEM

A. VoIP equipment shall utilize structured cabling (Section 27 10 10) and PoE ethernet switching equipment (Section 27 20 00).

B. Contractor shall provide a turnkey VoIP solution/installation and/or expansion to Owner's existing equipment as required to support all phones within the new Arena/Barn Buildings.

C. Solution/installation shall include, but is not limited to, the following:

1. Placing and patching handsets at workstation location through-out the facility.
2. Configuring/provisioning for user names, extensions, voicemail, etc.
3. Application/feature installation and configuration
4. System registration
5. Providing system training
6. Providing day one cutover support

D. General:

1. Contractor shall confirm exact make, model, configuration and accessories with Owner prior to placing order.
2. Contractor shall provide all labor, equipment, and required licenses to support new VoIP phones and/or server equipment.
    a. Category 6A RJ45 to RJ45 patch cables for phone handsets will be provided by the Structured Cabling Contractor.
3. Contractor shall provide 3-year maintenance contract.

E. Non-inclusive equipment list:

1. Avaya J139 handset (used in classrooms)
2. Avaya J159 handset (used in office areas)
3. Avaya J179 handset (TBD)
4. Avaya 182448 IP Office Server Edition Model
5. Avaya 700514867 IP Office IP500 V2A 2 RMU Control Unit
6. Avaya 700429202 IP Office IP500 Rack Mounting Kit
7. Avaya 700479710 IP Office IP500 V2 SD Media
8. Avaya 700504032 IP Office VCM Coding Module Media
9. Avaya 700504897 IP Office IP500 ATM4 V2 Combination Card
10. Avaya 700417231 IP Office IP500 Analog Extension Card
11. Avaya 396508 IP Office Server Ed License
12. Avaya 307318 License – Receptionist
13. Avaya 307350 License – Endpoint Device
14. Avaya 271683 IP Office IP500 3-year Maintenance Contract

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify rack grounding and bonding (Section 27 05 26).

B. Verify the appropriate circuit and uninterruptible power supply power circuit voltage, amperage and plug types were provided by the Division 26 and 27 contractors.

3.2 CONFIGURATION

A. Work with the Owner for configuration and asset tagging.

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 racks and/or cabinets are properly mounted/secured.

C. Ensure that a temperature between 65°F – 78°F and between 30% - 50% humidity is maintained in areas of voice equipment.

3.4 INSTALLATION

A. Install equipment following drawings, manufacturer’s instructions, and approved submittal data.

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 shared system equipment Vendors.

D. MDF/IDF equipment patch cables and associated patching of VoIP switch ports, within the MDF/IDF, will be provided by the Section 27 10 10 SCS Contractor.

E. Phone handset patch cables will be provided by the Section 27 10 10 SCS Contractor, but shall be installed by the VoIP system contractor/integrator. Coordinate procurement of these patch cables from the SCS Contractor.

F. The Owner shall be informed and will require a system inspection prior to the powering up of any equipment.

END OF SECTION

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SECTION 27 41 10

GENERAL REQUIREMENTS FOR AUDIO-VISUAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. 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 - Boxes for Electrical Systems
6. 27 10 10 – Voice and Data Cabling Distribution System
7. 27 05 00 – Common Work Results for Communications
8. 27 41 20 - Arena Integrated Audio-Visual Presentation System

1.2 RELATED DOCUMENTS

A. The General Provisions of the contract, as well as Division 1 general and supplementary conditions; documents issued shall apply to the work specified in this section.

1.3 DESCRIPTION.

A. This section establishes baseline requirements for general audio-visual (AV) infrastructure and components that are consistent across all AV systems within the project. It ensures standardization, compatibility, and efficient integration for common AV items, regardless of the specific AV system or application.

B. The purpose is to define materials, practices, and expectations for universally applied AV components, such as cable standards, mounting hardware, pass-through plates, and connectivity infrastructure. This specification complements system-specific requirements detailed in other sections.

C. Contractors shall ensure all installed systems and components meet or exceed the project’s performance requirements, applicable codes, and industry standards.

D. Contractors shall provide all necessary accessories, incidental items, and labor required to deliver fully operational systems, even if such items are not explicitly listed in the specification.

E. Coordination with other trades and disciplines as required to ensure compatibility with architectural, electrical, and IT systems, including proper cable management and adherence to installation best practices.

F. All systems shall be free of defects and calibrated for optimal performance. Documentation, labeling, and as-built records shall be provided to the owner for ease of operation and maintenance.

G. This section establishes a standardized approach to common AV equipment installation, promoting efficiency, reliability, and ease of use across the project.

1.4 INSTALLER QUALIFICATIONS

A. This section specifies the minimum qualifications required for an installing contractor to perform the installation of integrated Audio/Video (AV) systems. The contractor must meet the following criteria:

1. The contractor must have at least five (5) years of verifiable experience in successfully installing AV systems in projects similar in scope and nature to this one.
2. The contractor must demonstrate, and provide documentation of upon request, a proven track record of successfully completed installations in projects similar to this one.

3. The contractor must be an authorized dealer or distributor for the manufacturer's products specified in the project.
4. The contractor must maintain a fully staffed and equipped service facility capable of supporting the installation and ongoing maintenance of the AV system.

B. Equipment Expertise and Certifications:

1. The installing contractor must possess expertise in installing the specified AV equipment as outlined in the project specifications.
2. They should be well-versed in the installation and integration of AV components, including but not limited to speakers, amplifiers, mixers, microphones, displays, video switching and matrixing equipment, AV system control panels, DSPs, and other related AV equipment.
3. The contractor must hold current certifications from the manufacturers of the major components specified in the project including but not limited to Crestron, Shure, Extron, AMX, Cisco, Biamp, QSC, Sennheiser, black magic, etc. A copy of each certification must be included with the project documentation. Any submittals lacking these certifications will be automatically rejected.

C. Networking and Programming Expertise:

1. The contractor must have demonstrated experience in configuring and deploying AV-over-IP systems, including network design, bandwidth management, device configuration, QoS protocols to prioritize AV traffic on the network, ensuring optimal performance of audio and video streams.
2. The contractor must be familiar with relevant network protocols such as TCP/IP, UDP, IGMP, and multicast routing, which are essential for AV system communication and control.
3. The contractor should have experience setting up and managing Virtual LANs (VLANs) to segregate AV traffic from other network traffic, ensuring security and performance.
4. The contractor must be skilled in programming control systems (e.g., Crestron, AMX, Extron) to manage AV equipment, including custom scripting and automation of AV functions.

D. AVIXA Certification:

1. To ensure the quality of design and installation workmanship, the AV Integrator must employ at least one AVIXA Certified Technology Specialist (CTS) on a full-time basis, who will be working on this project. Employee(s) must hold current certifications at the time of project submittal. A copy of each certification, verifying their validity, must be included with the project documentation. Any submittals lacking these certifications will be automatically rejected.

E. Local Presence:

1. The installing contractor must maintain a physical office within a fifty (50) mile radius of the project site.
2. The office should serve as a base for communication, coordination, and support for the project.
3. local presence, such as a valid business address and contact information, must be provided.

F. These qualifications are mandatory and are essential to ensure that the installing contractor possesses the requisite experience, expertise, and local presence to successfully complete the sound system installation in K-12 school projects. Adherence to these qualifications will contribute to the quality and reliability of the sound systems in educational environments, providing an enhanced learning experience for students and educators.

1.5 QUALITY ASSURANCE

A. Warranty: The equipment and installation shall be warranted free from defects in materials and installation for a minimum period of five (5) years from final acceptance by the Owner.

B. Installer: Installation shall be done by Sound System Contractors regularly engaged in the business of sound system installations of this type, as evidenced by a record of similar satisfactory work performed within the last three years.

1.6 SUBMITTALS

A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Drawings must be done in a CAD program. Equipment lists, data sheets, etc. shall be 8-½” x 11" size, properly bound into a single or multiple volumes as necessary. Submit quantity in accordance with Division 1, General Requirements. Equivalent electronic copies are acceptable.

B. Within 12 weeks after the notice to proceed, submit to the Architect/Owner identical copies of the following for approval:

1. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item
2. Manufacturers' data sheets on all equipment items
3. Equipment rack layouts showing locations of all rack mounted equipment items
4. Floor plans and reflected ceiling plans, prepared at a scale of not less than 1/8”=1'-0", showing loudspeaker locations and orientation, wall plates, and all other related device locations
5. Proposed construction details for any custom fabricated items, including loudspeaker mounting, custom interface panels, patch panels, and wall plates. These details shall show dimensions, materials, finishes and color selection
6. Electrical power requirements for head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with the electrical contractor, showing exact conduit requirements and locations for switched duplex receptacles.

C. Close out document are provided as follows.

1. A complete as-installed equipment list, listed by room, with manufacturers' names, model numbers, serial numbers, and quantities of each item .
2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and codes shall be provided.
3. System performance measurements as noted elsewhere in this specification shall be documented. Include diagrams or charts showing final settings of all control knobs in the system (mixers, equalizers, power amplifiers, etc.). Submit copies of processor data files with software settings of each piece of equipment that is software controlled.
4. Floor plans and reflected ceiling plans, prepared at a scale of not less than 1/8"=1'-0", showing loudspeaker locations and orientation, wall plates, rack locations, and other related device locations.

1.7 AS BUILT SUBMITTALS

A. Upon completion of the work, but prior to final system acceptance, deliver three (3) sets of the following:

1. A complete and current record system schematic for all parts of the system, which shall include wire numbers, terminal block numbers and layouts and other designations and coding’s.
2. Any other record drawings showing parts of the system.
3. Repair parts lists for each and every equipment item furnished.
4. Service manuals for each component installed in the system.
5. Manufacturer's operating instructions for each and every equipment item.

1.8 COORDINATION WITH OTHER TRADES

A. General Coordination

1. The AV contractor shall coordinate with all relevant trades to ensure proper integration of AV systems with building infrastructure, conduit pathways, cable routing, and power requirements.

B. Conduit and Power

1. Coordinate with the electrical contractor to ensure conduit and cable pathways are sufficient and power is adequate for all AV equipment, including PoE devices.
2. Coordinate with electrical contractor to ensure isolated and clean power is provided for AV systems.

C. Structural Coordination

1. Work with the structural engineer to confirm that all AV mounting hardware is properly supported and meets building codes.
2. Coordinate with general contractor and architect to ensure any structurally mounted equipment is prepared and properly braced prior to installation of AV equipment.

D. D. Schedule Coordination

1. Align the AV installation schedule with the overall construction timeline in coordination with the general contractor and architect.

1.9 COORDINATION WITH OWNER IT

A. Network Integration, Security and QoS

1. Coordinate with the owner's IT department to integrate AV systems into the existing network, including IP addressing and VLAN configurations.
2. Ensure all networked AV devices comply with IT security policies and coordinate QoS settings to prioritize AV traffic on the network.

B. Testing and Documentation

1. Coordinate with the owners IT department in testing and provide necessary network documentation and training on managing the AV system.

1.10 REFERENCES

A. Specifications, Standards and Codes: All work shall be in accordance with the current editions of the following:

1. AVIXA Rack Building for Audiovisual System 2019
2. AVIXA Cable Labeling for Audiovisual Systems
3. ANSI T1.404 (DS3) and CATV Applications. 4. ANSI S4.48-1992
4. ANSI X3T9.5 TPPMD.
5. American Society of Testing and Materials (ASTM).
6. TIA (Telecommunications Industries Association &
7. EIA (Electronic Industries Alliance)
8. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual.
9. Federal Communications Systems (FCC).
10. Institute of Electrical and Electronics Engineers (IEEE).
11. National Electrical Code (NEC) (Latest revision and pertinent addendums).
12. National Electrical Manufacturer's Association (NEMA).
13. National Fire Protection Association (NFPA) Publications (Latest revisions and pertinent addendums).
14. "Basic Principles for suspended Loudspeaker Systems", Technical Notes Volume 1, Number 19, JBL Professional or latest edition.
15. "Handbook for Riggers" 1977 Revised Edition, Newberry, W.G., Calgary, Alberta Canada.
16. Underwriters Laboratory (UL)
17. Americans with Disabilities Act (ADA)
18. In the event of a conflict between documents referenced herein and the contents of this specification, the contents of this specification shall be considered the superseding document with the exception of the ADA, NFPA and NEC publications.
19. Society of Motion Picture and Television Engineers (STPME)

PART 2 - PRODUCTS

2.1 GENERAL

A. It is understood that materials become reach "end of life" or model numbers change. Should this occur for any materials listed in this specification, the AV Integrator shall replace with or better replacement components at no additional charge to the district. Additionally, since none of the materials listed in this specification are proprietary, and due to architectural coordination and system performance expectations, no substitutions will be allowed.

B. Should the sound contractor substitute a product not consistent with the specified product, it will be the sound contractor's responsibility to provide the specified product at no additional cost to the owner.

C. The following sections specifically list the acceptable equipment required for part of the system. Not all equipment is listed, but it is understood that it is the sound contractor's responsibility to furnish any and all equipment, labor, and miscellaneous items required for a complete and fully functional first-class, state of the art system, featuring the manufacturers latest model of the equipment shall be furnished and installed, whether specified herein or not.

D. Provide and install the following materials plus all associated or incidental items required for a fully complete and operational integrated audio-video system.

2.2 HDMI PASS THROUGH PLATE.

A. The HDMI input plate shall be the C2G 39870 HDMI Pass Through Single Gang Wall Plate with brushed aluminum finish or equal.

1. Provide and install with all necessary hardware and incidental components to complete the installation.

2.3 HDMI INTERCONNECT CABLE FOR HDMI PASS THROUGH PLATES.

A. The HDMI cable shall be the C2G Performance Series Plenum-Rated 4K HDMI Cable (C2G part number: 41461).

B. Ensure proper termination at both ends between HDMI pass-through wall plates.

1. Connect the Display side to the HDMI passthrough plate located behind the display and the source side to the HDMI passthrough plate located at the teacher's workstation.

C. Include all incidental items required for a complete installation.

2.4 2X2 LAY-IN CEILING AV ENCLOSURE

A. Refer to drawings for locations and quantity.

B. The ceiling-mounted AV enclosure shall be AtlasIED CR222-NR.

1. 2' x 2' ceiling-mount rack with a 2RU half-width AmbiTILT™ shelf system in a UL plenum-rated cabinet.
2. The enclosure shall feature an integrated power pack with five NEMA 5-15R outlets (125 VAC), controlled via a manual on/off switch.
3. Constructed from 16-gauge CRS frame and 18-gauge CRS panels, with natural air convection venting.
4. The enclosure shall support a maximum shelf load of 20 lbs per RU and have a total gross weight capacity of 68.5 lbs.
5. The enclosure shall have overall dimensions of 23.69" W x 23.67" D x 6.74" H, with a white powder coat exterior finish and black powder coat interior components.

C. Include CR222TRK mounting kit

D. Include CR222RR optional sliding rack rails.

E. Include threaded rod, bolts, clamps, and any other hardware needed for proper mounting.

2.5 MICROPHONE STANDS AND ACCESSORIES

A. When specified by other specifications, sections furnish and install the following:

1. Three (3) Atlas Sound MS-10C Leader Stand
2. Two (2) TL34E Two Piece Tripod Stand
3. Two (2) DS7E Desk Stand
4. Two (2) PB11X Boom Extension adapter

2.6 WIRE AND CABLE

A. Minimum Specifications

1. All wire and cable shall be UL approved, meet all national, state and local codes, and manufacturers recommendations for connected components for its intended application.
2. Plenum Insulation shall be rated for a minimum of 300 volts and satisfy the Underwriters Laboratories (UL) listed fire rated cable insulation requirements in plenum areas.
3. Cable runs shall be continuous runs. Mid-span cable splicing is not acceptable.

4. Any pulling compound or lubricant used in cable installation shall not deteriorate the conductor or the insulation.
5. All cabling shall have machine generated labels self-laminating or wrap around. Handwritten labels shall not be accepted.
6. Under carpet wiring and flat wiring shall not be used.
7. Manufacturers recommended cabling supersedes wire specified below.
8. Contractor responsible for verifying all plenum rated spaces prior to installation. Pro- vide Plenum rated cable as required.
9. Contractor to verify and provide cabling that is applicable to its installed environment.
10. All Pre-Amplifier audio cables shall be balanced unless otherwise noted.

B. HDBASET AND AVOIP CABLES

1. CAT6 or better

    a. Ensure that the cables pairs remain twisted together for canceling out Electromagnetic Interference (EMI) from the external sources are not exposed even partially, as it results in EMI issues.
    b. Use cables that are resistive to bend loss if excessive bending of cables cannot be prevented due to installation constraints.
    c. Avoid mounting the cabling components in places that block accessibility to other equipment (such as a power strip or fans) in and out of the racks.
    d. Avoid
    e. Applying extra twists.
    f. Pulling or stretching beyond the specified pulling load rate.
    g. Bending it beyond the specified bend radius, and not beyond 90º.
    h. Creating tension in the suspension runs.
    i. Stapling or applying pressure with the cable ties.

2. Avoid exposing cables to areas of condensation and direct sunlight.
3. Remove the abandoned cables, as they restrict the airflow, and contribute to the possible increase in the operational temperatures, which can affect the durability of the system.
4. The NEC (NFPA 70), Article 800.133 (2005 NEC) indicates the separation requirements. This section of the NEC specifies the following: Communication wires and cables shall be separated at least 50 mm (2 inches) from conductors of any electric, power, Class 1, non-power limited fire alarm, or medium-power network-powered broadband communication circuits. However, there are multiple exceptions to this generic rule, so refer to the NEC (NPFA 70) standard for more information.

C. Speaker Cable

1. West Penn Wire #25226, plenum rated 2-conductor # 14 AWG wiring to each speaker circuit with labels attached to both ends.

    a. Quantity as required.

D. Line Level Cable

1. West Penn Wire #25291B, plenum rated 2-conductor #22 AWG shielded to each microphone outlet and auxiliary outlet with labels attached to both ends.

    a. Quantity required.

E. XLR Cable

1. Hosa Pro Microphone Cable, REAN XLR3F to XLR3M by Neutrik AG, featuring silver-plated REAN connectors for superior signal transfer, 20 AWG x 2 Oxygen-Free Copper (OFC) conductors for a louder, clearer signal, and 90% OFC braided shield for a higher signal to noise ratio.

    a. Quantity and length as required.

F. RS-232 & COM CABLE

1. 6 conductors, 24 AWG stranded tinned copper, Beldfoil® (100% coverage) and a 65% tinned copper braid shield, along with a drain wire for proper grounding or equal.

    a. Coordinate jacket color

G. Auxiliary cables

1. 3.5 mm TRS plug to dual 1/4" TS plugs shall be equal to Whirlwind MST2TS06US
2. 3.5 mm TRS plug to dual XLR-M plugs shall be equal to Whirlwind MST2XM06US

H. Coaxial Cables

1. RF cabling shall be selected based on cable length and application to ensure minimal signal loss and optimal performance. All cables shall be manufactured by Belden, Canare, or Times Microwave and must meet industry standards for impedance, shielding, and signal attenuation. All cables must be terminated with the appropriate RF connectors and properly routed to avoid interference and degradation. Coaxial cable shall meet or exceed the following specifications based on application:

a. Wireless Microphone Antennas (RF) – 50Ω Coax

CABLE TYPE	MAX LENGTH CABLE RUN
LMR-240	Patch Cables or ≤ ft
LMR-400	≤100 ft
LMR-600	≤200 ft

b. SDI Video Signal – 75Ω Coax

CABLE TYPE	MAX LENGTH CABLE RUN	MAX RESOLUTION
6G-SDI	≤200 ft	4K30
12G-SDI	≤150 ft	4K60

2.7 CONNECTORS

A. Xlr Input And Output Wall/Floor Plates shall meet or exceed the following specifications:

1. 2 Punch Plate
   a. The wall plate shall be a Whirlwind WP1/2NDH stainless steel plate with two (2) ports, punched to accept Neutrik D-series connector or equal.
2. 4 Punch Plate
   a. The wall plate shall be a Whirlwind WP2/4NDH stainless steel plate with four (4) ports, punched to accept Neutrik D-series connector or equal.
3. XLR Input Connector(s)
   a. Each port shall be equipped with a Neutrik D-series female XLR input connector or equal.
4. XLR Output Connector(s)
   a. Each port shall be equipped with a Neutrik D-series male XLR output connector or equal.

B. Coaxial Cable Connectors and Terminations

1. All coaxial connectors, terminations, and pass-through interfaces shall be selected based on cable type, impedance, and application to ensure secure connections, minimal signal loss, and optimal performance.
2. All coaxial connectors shall meet the following minimum requirements:
   a. Impedance Matching – Connectors shall match the impedance of the cable (e.g., 50Ω for RF applications, 75Ω for SDI and video transport).
   b. Frequency Performance – Connectors shall be rated for the full frequency range of the associated cable and application, ensuring minimal attenuation and signal degradation.
   c. Shielding & Interference Protection – Connectors shall provide 360° shielding, preventing EMI/RFI interference in high-performance AV environments.
   d. Mechanical Integrity – All connectors shall be strain-relieved, vibration-resistant, and securely terminated to prevent degradation over time.
   e. Environmental Protection – Outdoor connectors shall be weatherproof, meeting IP67 or better standards where applicable.
3. Acceptable Connector Types & Applications
   a. BNC (Bayonet Neill-Concelman) – Primary connector for SDI video (75Ω) and RF applications (50Ω).
   b. Mini BNC – High-density SDI applications where space is limited.

c. TNC (Threaded Neill-Concelman) – RF applications requiring better shielding than BNC, including Wi-Fi and wireless microphones.
d. SMA & RP-SMA – Used for Wi-Fi, GPS, and high-frequency RF communications.
e. N-Type – High-power, low-loss RF applications in antenna feeds and long-distance transmission.
f. F-Type – Used for CATV, satellite, and consumer RF video applications.
g. UHF (PL-259) – Legacy RF applications, including CB and amateur radio.
h. MCX & MMCX – Used in miniature RF applications, embedded Wi-Fi, GPS, and IoT devices.

4. Termination & Installation Requirements

a. Connectors shall be crimp, clamp, or compression-style, based on manufacturer recommendations for the cable type.
b. All connectors shall be professionally terminated with proper tooling; twist-on or solder-only terminations are not acceptable.
c. Pass-through and wall plate connectors shall match the system impedance and be shielded where necessary to prevent EMI leakage.
d. Bulkhead connectors used in panel or rack-mounted installations shall provide strain relief and secure retention.

5. Approved Manufacturers

a. All connectors shall be manufactured by Neutrik, Amphenol, Kings, or equivalent high-performance manufacturers.
b. Generic, unbranded, or low-cost bulk connectors shall not be acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. This Section includes installation requirements of the Integrated Audio-Video. If you have any questions regarding the intent or application of any feature, submit these questions to the principal contact for this project, as indicated in Division 00. This section covers the general requirements for the installation of the equipment by the Contractor.

1. All work shall be done in a thorough and conscientious manner according to industry standards and shall be subject to inspection and acceptance.
2. The Contractor shall be certain that all installation work areas are secure and made safe in accordance with Occupational Safety and Health Administration (OSHA) regulations.
3. An appropriate construction schedule shall be developed by the Contractor and will be subject to approval by the customer's representatives. The construction schedule should include at least one installation supervisor, or lead technician, for on-site management of the project.
4. Prior to starting the installation, the assigned installation supervisor, or lead technician, shall participate in a "walk-through" of the project location with the customer's representatives to review the installation documentation, verify that all construction necessary for the installation has been completed, and verify all installation methods and cable routes.
5. The Contractor shall be responsible for completing a standardized report form addressing the weekly progress of the installation schedule.
6. The Contractor shall maintain conductor polarity identification at the main equipment room, backbone, and horizontal connections in accordance with industry practices.
7. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the system.
8. The Contractor shall be responsible for labeling all cable, distribution frames, and out- let locations, according to industry standards.
9. It shall be the responsibility of the installation Contractor to furnish any special installation equipment or tools necessary to properly complete the installation.
10. The Contractor shall not roll or store cable reels without an appropriate underlay.
11. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

12. The Contractor shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during the placement facilities. Failure to follow the appropriate guidelines may require the Contractor to provide additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation Contractor during the implementation.
13. The Contractor shall plug conduits where cabling has been installed by the installation Contractor in the equipment rooms, backbone and other cable entrance locations with re-enterable duct seal of flame-retardant putty.
14. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment are required, these units shall be the product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.
15. Wiring, materials, and equipment will be delivered and stored in a clean dry space. They will be properly packaged in factory fabricated type containers and protected from damaging fumes, construction debris and traffic until job completion.
16. The wiring, materials, and equipment furnished for this request shall be essentially the standard product of the manufacturer.
17. All installation techniques and fixtures shall result in ease of maintenance and ready access to all components for testing measurements. All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be used unless specifically approved by the customer's representatives. All parts shall be made of corrosion resistant material, such as plastic, anodized aluminum or brass. All materials used in installation shall be resistant to fungus growth and moisture deterioration. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.
18. The Contractor will submit for approval, a detailed description of the procedures and equipment included for the complete operational installation.

B. Control Systems

1. Contractor shall meet with owner and whomever the Owner deems appropriate to dis- cuss control features and navigation. Once agreement is received on the control navigation, the Contractor shall submit detailed documentation and GUI configuration and programming for approval. This process will continue until the contractor obtains documented approval from the Owner for control design. Contractor shall provide reasonable hours for changes once the system is operational to ensure the Owner's satisfaction. The control software shall be delivered to the Owner upon substantial completion of the project.

C. Wiring Plan Requirements

1. Distribution of the cabling will be accomplished through cable trays, conduit raceways, ducts, core-holes, extended columns, false half columns and plenums. Cabling shall be run at right angles from cable trays. Horizontal cable segments will be placed in cable trays and with cable exits/entrances supported by distribution rings or J Hooks. Cable may not rest on ceiling tile, be supported on existing ducting, tied, or supported by fire alarm, security or electrical infrastructure nor interlaced with existing cable.
2. The Contractor shall be responsible for providing an approved ground at all equipment locations. The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and frameworks. All grounds shall consist of a minimum of 12 AWG copper wire or larger as required by code and shall be supplied from an approved building ground and bonded to the main electrical ground.
3. Observe proper circuit and loudspeaker wiring polarity. Properly and clearly label connections and wires as to function and polarity. No cables will be wired with polarity re- versal between connectors, at either end. Take care when wiring microphone cables to ensure that constant polarity is maintained.

D. Cable Management

1. Maintain segregation of cables. AC power cables or speaker cables should not be run parallel within proximity to signal wires (within 2"), unless the wires are twisted.
2. The bend radius for twisted-pair cables is standardized at 12" (3" diameter).
3. Bundle cables within the guidelines of 2005 National Electrical Code (NEC) in Article 310.15(B)(2).

E. Rack Dressing

1. All Racks require Lacer Bars or Strips to provide clean cable management withing the rack.
2. All racks require the cable segregation of AC cables, Speaker Cables, low impedance balanced cabling and twisted pair cables.

3. All AV Racks should be assembled and tested at the Contractor's facility and trans- ported to the job site when possible.
4. No Cable Ties; Velcro only.

F. Identification, Labeling and Documentation

1. The Contractor shall label all termination devices, panels, enclosures and equipment rooms. The Contractor will mark each unit with permanently attached, self-laminating markings that will not impair the equipment or present a hazard to maintenance personnel.
2. Place wire identification numbers on each end of all conductors. Install markers to be readable from left to right or top to bottom. Wire numbers shall be computer printed. Handwritten labels are not acceptable.
3. Mark all spare conductors and coil them neatly located at the bottom of the equipment rack.

3.2 TESTING REQUIREMENTS

A. The Contractor shall perform sample tests in the presence of the customer's representatives. Performing the testing procedures specified herein assures that the equipment and interconnection meets the performance characteristics specified. If testing indicates that the performance characteristics are not met, the test shall be declared a failure. The communication equipment and interconnection cabling shall be modified and/or repaired accordingly. The failed test and any other test that may be affected by the modification and/or repair shall be rerun. After all components have been installed, the integrity of the equipment and interconnection cabling shall be verified.

B. If system test fails because of any component(s) in the system, the failed component(s) shall be corrected or substituted with other components and the tests shall be repeated. If a component has been modified because of the system test failure, a report shall be prepared and delivered to the customer's representatives prior to retesting. The Contractor shall prepare and submit all test procedures and data forms for the post installation and system test to the customer's representatives.

C. The test report shall contain the description of all tests performed, the results obtained, and any required adjustments or modifications necessary because of testing and installation. This report shall reflect the as-built communication equipment and interconnection cabling. An authorized representative of the Contractor shall sign the test report. At least three copies of the test report shall be sent to the customer's representatives.

1. Sample Test Report:

ITEM	ROOM/AREA	INPUT / OUTPUT	SOURCE	TEST RESULT	RECOMMENDED CORRECTIVE ACTION
1	Cafeteria Stage	AV-01 HDMI IN	Tech Laptop	No image displayed.	Verify HDBaseT connectivity on 12/25/19.

D. The test procedures shall have the Owner's representative's approval before the tests.

E. Contractor shall demonstrate to the Owner's representatives that the equipment operates as specified and that the tests meet performance requirements.

F. The Contractor shall ensure that the equipment is in first-class working condition and free of short circuits, ground loops, parasitic oscillations, excessive hum, RF interference, or instability of any form.

G. The Contractor shall test each operational component and adjust for equal sound levels at a given volume setting and replace defective items.

H. The contractor shall ensure that all loudspeaker and distributed audio systems described herein are balanced and optimized for maximum quality sound and coverage of listening areas.

3.3 TRAINING

A. System training shall be provided for the operator/user and technical staff.

1. Operator/user training shall be held at the Owner's convenience and to the Owner's satisfaction.
2. Technical operation and maintenance training shall be held at Owner's convenience and to the Owner's satisfaction.

3. The Contractor shall provide documentation demonstrating the Owner and/or Owner's Representatives understand the operation and maintenance of the system.
4. Complete operation and maintenance manuals and preliminary as-built drawings shall be delivered to the Owner one week prior to training sessions.

B. Operator/user training shall minimally consist of:

1. Provide printed reference material for each trainee that documents and explains in layman's terms:

   a. System block diagram
   b. Normal day-to-day operation
   c. Operator selectable features

2. Provide a hands-on training with Q & A session

C. Technical Operations and Maintenance training shall consist of:

1. The technical explanation shall be sufficiently thorough that staff personnel shall be able to make any programming changes required, analyze malfunctions and make equipment substitutions or bypasses necessary to maintain system operation except for the malfunctioning equipment or circuits.
2. Provide printed reference material for each trainee that documents and explains in technical terms:

   a. System block diagram with technical features
   b. Technical operation, adjustments and programming
   c. System features and programming
   d. Review of as-built drawings.

3. Provide hands-on training with Q & A session.

D. The contractor will provide a complete and comprehensive list of the maintenance schedule for all installed and/or provided equipment.

3.4 ACCEPTANCE OF SYSTEMS

A. Specifications set forth for construction of the system have been devised to ensure system compatibility and performance. Compliance to these specifications will be determined during periodic observances of construction. Repeated failure to comply with the specification will be considered before the initial acceptance phase of the plant commences.

B. Prior to Contractor performing final testing, deliver preliminary as-build documents to Owner for use in conducting testing observation.

C. Project Record Documentation

1. Upon completion of final engineering and incorporation of the Architect review comments, Contractor will provide to the Architect for its records the following close out documentation:
2. Record or As Build Drawings which shall include but not limited to:

   a. Functional block diagrams for each Integrated Audio-Video System
   b. All Integrated Audio-Video or Audio-Visual junction box locations
   c. Audio Visual equipment rack locations
   d. Rack elevations

      1) Rack elevations shall show all components as installed under this contract.
      2) Contractor will label each component describing the component. (Examples: Cafeteria Amplifier or Gymnasium DSP etc.).

   e. Floor plan drawings with device locations and associated assigned item number.
   f. Mounting detail for equipment and hardware.
   g. Schedule of all devices with associated panel termination, zoning, power circuits, etc.
   h. Corrected product submittal information

3. A complete inventory list of installed products shall include:

   a. Manufacture Name
   b. Model Number
   c. Serial Number
   d. Room number and/or description of installed location

4. Operation and Maintenance Manuals shall include

    a. Include detailed procedures for system operation that begin with startup procedures and continue through system shut down referenced in section 3.3 Training.
    b. List of manufacture recommended maintenance and intervals with manufacture support contact information.

D. Drawings will contain the Contractor's own title block on the edge of the drawing. The title block shall contain the following information and adhere to the following requirements:

1. Company name
2. Company address and phone number for service
3. Date on the drawings will match the date of acceptance for warranty purposes
4. Do not use any part of the consultant / architect title block, copyright data or seals. Failure to remove these items will result in the document being returned stamped re- vise and resubmit.

E. Drawing documentation will be in the following format:

1. One (1) electronic copy transmitted to the general Contractor through their approved transmittal process.
2. Drawings will be in both CAD (DWG) and PDF format.
3. File transfer is acceptable.

F. Drawings shall be provided to the architect two weeks prior to the final testing and commissioning of the system. Coordinate with the Owner during the pre-construction meeting for low voltage Contractors to schedule this delivery date.

G. The drawings will be reviewed on site with the architect and the Owner prior to the final acceptance process. Drawings rejected for any reason will delay the final acceptance process until resolved.

H. Testing Results

1. In addition to the project record drawings, the Contractor shall provide the testing in- formation for all audio-visual cabling.
2. Test results shall be provided to the architect two weeks prior to expected final acceptance of the system(s). Coordinate with the Owner during the pre-construction meeting for low voltage Contractors to schedule this delivery date.
3. The drawings will be reviewed on site with the architect and the Owner prior to the final acceptance process. Test results rejected for any reason will delay the final acceptance process until resolved.

I. Once accepted by the architect and Owner all documentation / program code becomes the property of the Owner

J. Within ten days of receipt of the final acceptance notice, the Owner's representatives shall schedule and perform the final inspection. When the work is found acceptable under the contract documents and the contract is fully performed, declare substantial completion of the project.

3.5 WARRANTY

A. The Contractor shall warrant and guarantee all work against defects in material, equipment or workmanship for one (1) year from the date of substantial completion of the entire project.

B. Upon receipt of written notice, Contractor shall remedy defects within thirty (30) days, or the Owner shall correct the defects and the Contractor, or its surety shall be liable for expenses.

END OF SECTION

SECTION 27 41 26

ARENA INTEGRATED AUDIO-VISUAL PRESENTATION SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. 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 - Boxes for Electrical Systems
6. 27 10 10 - Voice and Data Cabling Distribution System
7. 27 05 00 - Common Work Results for Communications
8. 27 41 10 - General Requirements for Audio-Visual Systems

1.2 RELATED DOCUMENTS

A. The General Provisions of the contract, as well as Division 1 general and supplementary conditions; documents issued shall apply to the work specified in this section.

1.3 DESCRIPTION

A. The integrated audio-video system shall be a fully functional, turnkey AV system featuring a large-format LED video wall display utilizing digital video processing and distribution to ensure low-latency, high-resolution content delivery, with multiple presenter stations which will also function as scorekeepers / system control stations. The system shall also include manned camera locations, which have the necessary connections to allow for a man operated camera to provide a live stream of video into the AV system. The system shall feature two distinct modes of operation to accommodate different event requirements and different levels of operators:

1. Simple Mode – Designed for day-to-day operation without dedicated AV system operators. A wall-mounted touchscreen provides users with the ability to switch between the two modes of operation, as well as provide master volume control, and select sources (microphone, Bluetooth, or HDMI). In this mode video content shall be streamed from the HDMI input at any of the presenter stations and seamlessly and automatically display the media content form the HDMI source on the LED wall in a full screen format. All audio processing, mixing, and distribution shall be managed by the system's DSP to ensure consistent sound quality without manual adjustment.
2. Advanced Mode – Enables full live event production capabilities for competitions, performances, and live-streamed events. In this mode, a mobile workstation is deployed, allowing operators to connect a video switching control surface, media generation and graphics processing unit, and an audio mixing console. In this mode the system is controlled via the mobile workstation and is capable of real time, multi-input video switching, real-time score integration, and manual audio mixing for professional-level event management.

B. System Performance

1. The video system shall be built on an AVoIP backbone, supporting digital signal processing and distribution for seamless integration across all displays.
2. Each Presenter station will consist of an HDMI over IP encoder, as well as a dedicated 10G Cat6 connection for control surface signals. The system shall provide multiple input sources at the presenter stations, including HDMI for video input, Bluetooth for wireless audio streaming, XLR inputs for wired microphones, and a dedicated touchscreen control panel for simplified operation.
3. The sound system shall deliver full-range audio with a frequency response of 20 Hz to 20 kHz, maintaining a minimum SNR of 85 dB, ≤0.5% THD at full output, and a noise floor not exceeding 25 dB(A). The system shall provide 110 dB ±3 dB continuous SPL, with peaks of 130 dB RMS / 133 dB

peak. Latency shall not exceed 5ms, and the system shall maintain a direct-to-reverberant ratio of ≥6 dB at all listening positions, ensuring clear, intelligible audio for both speech and music applications.

4. Wireless and wired microphone systems shall be included to accommodate flexible event configurations.
5. The system shall include digital scorekeeping software integrated with the presentation system, allowing seamless scoreboard management.

C. Thorough end-user training shall be provided to the faculty, as approved by the owner's representative, to ensure confident operation of the system. Due to the potential for staff changes from year to year, end-user training shall be provided for the life of the system at no additional charge to the owner. Additionally, an audio-video recording of each training session shall be provided to the school staff and district director within 5 working days after the training takes place. A letter, signed by the President of the AV Integrator, acknowledging that end-user training will be provided for the life of the system at no additional charge, shall accompany the complete set of design submittals. Submittals without this letter will be rejected.

D. The AV integrator shall provide extensive end-user training to ensure proper system operation, content creation, and troubleshooting. Training shall cover system control, video playback, audio mixing, and digital scorekeeping software. Custom graphics and content templates shall be developed in collaboration with the owner to ensure smooth event operation.

1.4 INSTALLER QUALIFICATIONS

A. This section specifies the minimum qualifications required for an installing contractor to perform the installation of integrated Audio/Video (AV) systems. The contractor must meet the following criteria:

1. The contractor must have at least five (5) years of verifiable experience in successfully installing AV systems in projects similar in scope and nature to this one.
2. The contractor must demonstrate, and provide documentation of upon request, a proven track record of successfully completed installations in projects similar to this one.
3. The contractor must be an authorized dealer or distributor for the manufacturer's products specified in the project.
4. The contractor must maintain a fully staffed and equipped service facility capable of supporting the installation and ongoing maintenance of the AV system.

B. Equipment Expertise and Certifications:

1. The installing contractor must possess expertise in installing the specified AV equipment as outlined in the project specifications.
2. They should be well-versed in the installation and integration of AV components, including but not limited to speakers, amplifiers, mixers, microphones, displays, video switching and matrixing equipment, AV system control panels, DSPs, and other related AV equipment.
3. The contractor must hold current certifications from the manufacturers of the major components specified in the project including but not limited to Crestron, Shure, Extron, AMX, Cisco, Biamp, QSC, Sennheiser, black magic, etc. A copy of each certification must be included with the project documentation. Any submittals lacking these certifications will be automatically rejected.

C. Networking and Programming Expertise:

1. The contractor must have demonstrated experience in configuring and deploying AV-over-IP systems, including network design, bandwidth management, device configuration, QoS protocols to prioritize AV traffic on the network, ensuring optimal performance of audio and video streams.
2. The contractor must be familiar with relevant network protocols such as TCP/IP, UDP, IGMP, and multicast routing, which are essential for AV system communication and control.
3. The contractor should have experience setting up and managing Virtual LANs (VLANs) to segregate AV traffic from other network traffic, ensuring security and performance.
4. The contractor must be skilled in programming control systems (e.g., Crestron, AMX, Extron) to manage AV equipment, including custom scripting and automation of AV functions.

D. AVIXA Certification:

1. To ensure the quality of design and installation workmanship, the AV Integrator must employ at least one AVIXA Certified Technology Specialist (CTS) on a full-time basis, who will be working on this project. Employee(s) must hold current certifications at the time of project submittal. A copy of each certification, verifying their validity, must be included with the project documentation. Any submittals lacking these certifications will be automatically rejected.

E. Local Presence:

1. The installing contractor must maintain a physical office within a fifty (50) mile radius of the project site.
2. The office should serve as a base for communication, coordination, and support for the project.
3. local presence, such as a valid business address and contact information, must be provided.

F. Manufacturer Certification and Authorized Vendor Requirement

1. The installing contractor must be a certified partner, authorized dealer, or approved vendor for all major manufacturers of the equipment specified in this document.
2. The contractor must provide documentation of their partnership or authorization status from the manufacturers upon request.
3. The contractor must procure all equipment directly from the manufacturer or an authorized distributor, ensuring full manufacturer warranties and support apply.

G. These qualifications are mandatory and are essential to ensure that the installing contractor possesses the requisite experience, expertise, and local presence to successfully complete the sound system installation in K-12 school projects. Adherence to these qualifications will contribute to the quality and reliability of the sound systems in educational environments, providing an enhanced learning experience for students and educators.

1.5 QUALITY ASSURANCE

A. Warranty: The equipment and installation shall be warranted free from defects in materials and installation for a minimum period of five (5) years from final acceptance by the Owner.

B. Installer: Installation shall be done by Sound System Contractors regularly engaged in the business of sound system installations of this type, as evidenced by a record of similar satisfactory work performed within the last three years.

1.6 SUBMITTALS

A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Drawings must be done in a CAD program. Equipment lists, data sheets, etc. shall be 8-½” x 11" size, properly bound into a single or multiple volumes as necessary. Submit quantity in accordance with Division 1, General Requirements. Equivalent electronic copies are acceptable.

B. Within 12 weeks after the notice to proceed, submit to the Architect/Owner identical copies of the following for approval:

1. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item
2. Manufacturers' data sheets on all equipment items
3. Equipment rack layouts showing locations of all rack mounted equipment items
4. Floor plans and reflected ceiling plans, prepared at a scale of not less than 1/8”=1'-0", showing loudspeaker locations and orientation, wall plates, and all other related device locations
5. Proposed construction details for any custom fabricated items, including loudspeaker mounting, custom interface panels, patch panels, and wall plates. These details shall show dimensions, materials, finishes and color selection
6. Electrical power requirements for head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with the electrical contractor, showing exact conduit requirements and locations for switched duplex receptacles.

C. Close out document are provided as follows.

1. A complete as-installed equipment list, listed by room, with manufacturers' names, model numbers, serial numbers, and quantities of each item.
2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and codes shall be provided.
3. System performance measurements as noted elsewhere in this specification shall be documented. Include diagrams or charts showing final settings of all control knobs in the system (mixers, equalizers, power amplifiers, etc.). Submit copies of processor data files with software settings of each piece of equipment that is software controlled.
4. Floor plans and reflected ceiling plans, prepared at a scale of not less than 1/8"=1'-0", showing loudspeaker locations and orientation, wall plates, rack locations, and other related device locations.

1.7 AS BUILT SUBMITTALS

A. Upon completion of the work, but prior to final system acceptance, deliver three (3) sets of the following:

1. A complete and current record system schematic for all parts of the system, which shall include wire numbers, terminal block numbers and layouts and other designations and coding’s.
2. Any other record drawings showing parts of the system.
3. Repair parts lists for each and every equipment item furnished.
4. Service manuals for each component installed in the system.
5. Manufacturer's operating instructions for each and every equipment item.

1.8 COORDINATION WITH OTHER TRADES

A. General Coordination

1. The AV contractor shall coordinate with all relevant trades to ensure proper integration of AV systems with building infrastructure, conduit pathways, cable routing, and power requirements.

B. Conduit and Power

1. Coordinate with the electrical contractor to ensure conduit and cable pathways are sufficient and power is adequate for all AV equipment, including PoE devices.
2. Coordinate with electrical contractor to ensure isolated and clean power is provided for AV systems.

C. Structural Coordination

1. Work with the structural engineer to confirm that all AV mounting hardware is properly supported and meets building codes.
2. Coordinate with general contractor and architect to ensure any structurally mounted equipment is prepared and properly braced prior to installation of AV equipment.

D. D. Schedule Coordination

1. Align the AV installation schedule with the overall construction timeline in coordination with the general contractor and architect.

1.9 COORDINATION WITH OWNER IT

A. Network Integration

1. Coordinate with the owner’s IT department to integrate AV systems into the existing network, including IP addressing and VLAN configurations.

B. Security and QoS

1. Ensure all networked AV devices comply with IT security policies and coordinate QoS settings to prioritize AV traffic on the network.

C. Testing and Documentation

D. Involve the owners IT department in testing and provide necessary network documentation and training on managing the AV system.

PART 2 - PRODUCTS

2.1 GENERAL

A. It is understood that materials become reach “end of life” or model numbers change. Should this occur for any materials listed in this specification, the AV Integrator shall replace with or better replacement components at no additional charge to the district. Additionally, since none of the materials listed in this specification are proprietary, and due to architectural coordination and system performance expectations, no substitutions will be allowed.

B. Should the sound contractor substitute a product not consistent with the specified product, it will be the sound contractor’s responsibility to provide the specified product at no additional cost to the owner.

C. The following sections specifically list the acceptable equipment required for part of the system. Not all equipment is listed, but it is understood that it is the sound contractor’s responsibility to furnish any and all equipment, labor, and miscellaneous items required for a complete and fully functional first class, state of the art system, featuring the manufacturers latest model of the equipment is to be furnished and installed, whether specified herein or not.

D. Furnish and install the required signal processing equipment **INSIDE** the sectional equipment cabinet(s). Furnish and install blank panels as required to cover all open rack spaces in the sectional cabinet. Install required mixers, amplifiers, and signal processors, inside rack. Furnish power filters and 120 VAC power distribution outlets inside the racks as required for plugging of all the below equipment.

2.2 EQUIPMENT RACKS AND POWER SEQUENCING, CONDITIONING, AND CONTROL

A. Furnish equipment racks to house equipment as shown on drawings.

B. Installation of wall rack back plane is provided by electrical contractor of division 26.

C. Grounding and bonding shall be in compliance with the sections listed in 1.1 RELATED SECTIONS of this document.

D. Refer to drawings for power requirements.

E. Equipment Rack

1. 46RU High Strength Wall Cabinet with Adjustable Rails, 32 inch Deep. Middle Atlantic SR28-46-32 (QTY -1)
    a. Include vented front door LVFD28-46 (QTY-1)
    b. Include vented blank filler panels to cover all blank spaces inside equipment rack. (Qty-As required)
    c. Include with 2RU sliding vented shelf Middle Atlantic SSHD-28. (Qty-as needed for equipment)
    d. Include with Middle Atlantic DWRSR-138FT-K-EU Fan Kit.
    e. Include rack storage drawer with foam lining SD3-14. (QTY-1)

F. Power Sequencing, Conditioning, and Control

1. Sequencing Controller – Middle Atlantic USC-6R (QTY-2)
2. Modular Power Raceway – Middle Atlantic MPR-8A (QTY-1)
    a. Expandable power distribution system
    b. 8-outlet modular power raceway
3. Power Modules – Middle Atlantic RLM-20-1CA (QTY As Needed)
    a. 20A individually controlled power modules
    b. Provides isolated power control for critical AV equipment
4. Power Conditioner with Voltage Regulation – Furman P-2400 AR (QTY-2)

a. Provides automatic voltage regulation (AVR) to protect against brownouts, sags, and overvoltage
b. EMI/RFI filtering eliminates electrical noise from arena lighting, motors, and HVAC
c. 20A capacity with true power conditioning for stable, clean power to all AV equipment
d. Contractor shall play

2.3 MOBILE WORKSTATION AND EQUIPMENT RACK.

A. The mobile workstation and equipment rack shall be Titan AV+ RC-SC-AMC16UD or equivalent.

1. Include Casters as recommended by manufacturer.
2. Include with 2RU sliding vented shelf Middle Atlantic SSHD-28. (QTY-1)
3. Include rack storage drawer with foam lining SD3-14. (QTY-1)
4. Include 20A Power Conditioner FURMAN PL-PROC. (QTY-1)
5. Power Conditioner with Voltage Regulation – Furman P-2400 AR (QTY-1)

2.4 LED VIDEO WALL DISPLAY

A. The approved manufacturer for the LED wall display and display system shall be Daktronics

B. The LED video wall shall consist of JVX-1000-3.9MN-6000-WD panels

1. high-resolution digital display with a 3.9mm pixel pitch, 768 x 1280 resolution, and an active screen size of 9.84 feet x 16.41 feet (3m x 5m). The display shall feature 6,000-nit brightness, a 160° horizontal viewing angle, and a 100,000-hour LED lifespan. The cabinet shall be constructed from die-cast aluminum, ensuring durability and efficient heat dissipation. The display shall be IP-66 rated on the front and IP-65 rated on the rear, with front or rear service access for maintenance.
2. The LED wall shall consist of 240 total LED Modules in a12 modules high by 20 modules wide configuration.

C. The LED video wall processor shall be Daktronics VP-6000 (QTY-1)

1. The video processor shall provide low-latency, high-resolution video processing for live events and digital displays. It shall support multiple input/output configurations, including SDI and HDMI, ensuring seamless integration with the Daktronics Show Control system. The processor shall include advanced video refinement functions, such as keying effects and video mixing, allowing real-time content manipulation. The unit shall be rack-mounted and designed for 24/7 operation in demanding broadcast and live event environments.

D. Graphics Generator rack mount shall be Daktronics GFX Live NDI 1CH (Qty-1)

1. The graphics generator shall be a real-time NDI-based video processing unit designed for live event and sports broadcasting. It shall enable real-time graphics overlay and score bug generation, providing broadcast-quality visuals in a compact form factor. The system shall support NDI|HX video streaming, ensuring efficient bandwidth utilization for networked video workflows.

E. Graphics Generator mobile work station shall be Daktronics GFX book Live 1CH (Qty-1)

1. The graphics generator shall be a real-time NDI-based video processing unit designed for live event and sports broadcasting. It shall enable real-time graphics overlay and score bug generation, providing broadcast-quality visuals in a compact form factor. The system shall support NDI|HX video streaming, ensuring efficient bandwidth utilization for networked video workflows.
2. Located at mobile work station.

F. Digital Media Player shall be Daktronics DMP-8000 (Qty-1)

1. The digital media player shall support playback of high-definition video, images, and animations in live event settings. It shall be fully integrated with the Daktronics Show Control Suite, providing scheduled and real-time content playback. The unit shall offer multiple output options, including HDMI and SDI, ensuring compatibility with LED displays and video processing systems.

G. System Integration with Daktronics Show Control Suite

1. The Daktronics Show Control Suite shall serve as the centralized control platform, managing all video processing, graphics generation, media playback, and display interfacing within a unified ecosystem. The system shall enable real-time monitoring and adjustment, ensuring seamless content delivery across all connected devices.

2.5 65” FLAT PANEL DISPLAYS (AUXILLIARY PROGRAM VIDEO)

A. The 65” Flat panel display shall be Samsung QN65LST7T – 65" Outdoor QLED Smart TV

1. 65" 4K UHD QLED display, 60Hz refresh rate, IP55-rated for outdoor use, with (3) HDMI, (1) USB, HDBaseT, RS-232, LAN, optical audio, Wi-Fi, and Bluetooth® connectivity; includes 20W 2-channel speakers with Dolby® Digital Plus and voice amplifier.

B. Include with articulating wall mount providing a minimum of 45° swivel, 12° tilt, and 18" extension. Mount shall be compatible with 400mm x 400mm VESA pattern.

C. Provide with AVoIP device decoder as specified below.

D. Refer to drawings for locations and quantities.

2.6 VIDEO SWITCHER AND CONTROL SURFACE

A. Video Switcher shall be Blackmagic ATEM 1 M/E Constellation HD (Qty-1)

1. The video switcher shall be a high-definition live production switcher designed for real-time video mixing and broadcast-quality switching. It shall feature 10 SDI inputs, each with frame resynchronization and format conversion, ensuring seamless operation with mixed video sources. The unit shall include 4 upstream keyers, 1 downstream keyer, and 4 advanced chroma keyers, supporting complex live video effects. The switcher shall integrate with Blackmagic ATEM Software Control Panel for remote operation and offer Ethernet connectivity for integration into larger production workflows.

B. Video Switcher Control Surface shall be Blackmagic ATEM 1 M/E Advanced Panel 10 (Qty-1)

1. The hardware control panel shall provide dedicated tactile controls for fast, professional video switching with integrated control over transitions, effects, and media playback. It shall include high-quality curved buttons with customizable LED backlighting, a smooth weighted T-bar fader, and a three-axis joystick for DVE and camera control. The panel shall feature Ethernet connectivity, allowing direct connection to the ATEM 1 M/E Constellation HD via network or direct cable.

2.7 AV POE SWITCH FOR MAIN EQUIPMENT RACK

A. The AV POE switch shall be NETGEAR M4250-40G8XF-PoE+ (GSM4248PX). (QTY-1)

1. The switch shall be optimized for AV-over-IP applications, providing 40 Gigabit PoE+ ports with a total budget of 960W along with 8 SFP+ 10G fiber uplink ports. The switch shall support layer 2/3 switching, VLAN segmentation, IGMP snooping, QoS prioritization for AV traffic, and multicast routing. The unit shall be rack-mountable and include an AV GUI for simplified configuration.

B. Include all necessary hardware, cables, and connectors.

C. Coordinate with owners representative for networking configuration.

D. Provide with 10GBase-t SFP+ transceiver with rj45 receptacle for cat6a or cat7 cabling equal to NETGEAR AXM765v

1. SFP Module shall be used to establish the 10G link between the primary switch and the secondary mobile workstation switch.

2.8 AV POE SWITCH FOR MOBILE WORKSTATION

A. The AV POE switch shall be NETGEAR M4250-10G2XF-PoE+ (GSM4212PX). (QTY-1)

1. The switch shall be optimized for AV-over-IP applications, providing 8 Gigabit PoE+ ports and 2 additional non POE ports with a total budget of 240W along with 2 SFP+ 10G fiber uplink ports. The switch shall support layer 2/3 switching, VLAN segmentation, IGMP snooping, QoS prioritization for AV traffic, and multicast routing. The unit shall be rack-mountable and include an AV GUI for simplified configuration.

B. Include all necessary hardware, cables, and connectors.

C. Coordinate with owners representative for networking configuration.

D. Provide with 10GBase-t SFP+ transceiver with rj45 receptacle for cat6a or cat7 cabling equal to NETGEAR AXM765v

1. SFP Module shall be used to establish the 10G link between the primary switch and the secondary mobile workstation switch.

2.9 AVoIP DEVICE/END-POINT ENCODER/DECODER

A. Encoder shall be Extron NAV E 121

1. Refer to drawings for quantity and locations.
2. Include all necessary power supplies, cables, connectors, and hardware.

B. Decoder shall be Extron NAV E 101

1. Refer to drawings for quantity and locations.
2. Include all necessary power supplies, cables, connectors, and hardware.

2.10 HDMI TO SDI CONVERTER

A. The converter shall be equal to Blackmagic Micro Converter HDMI to SDI 3G (Qty as shown in drawings)

1. The converter shall provide real-time HDMI to SDI signal conversion for professional AV and broadcast applications. It shall support full HD resolutions up to 1080p60, with automatic format detection and dual 3G-SDI outputs. The unit shall include relocking technology for signal integrity and low-latency transmission. It shall be compact, lightweight, and powered via USB-C, making it suitable for both fixed installations and portable setups.
2. Include all necessary power supplies, cables, connectors, and hardware.

2.11 SDI TO HDMI CONVERTER

A. The converter shall be equal to Blackmagic Micro Converter HDMI to SDI 3G (Qty as shown in drawings)

1. The converter shall provide real-time HDMI to SDI signal conversion for professional AV and broadcast applications. It shall support full HD resolutions up to 1080p60, with automatic format detection and dual 3G-SDI outputs. The unit shall include relocking technology for signal integrity and low-latency transmission. It shall be compact, lightweight, and powered via USB-C, making it suitable for both fixed installations and portable setups.
2. Include all necessary power supplies, cables, connectors, and hardware.

2.12 AMPLIFIER

A. The speaker amplifier shall be CROWN CDi 2000. (QTY-2)

1. 2-Channel Amplifier with (2) channels, each capable of delivering 1250W into 2Ω, 4Ω, 8Ω, 70Vrms, and 100Vrms loads. The amplifier features Crown's proprietary and patented DriveCore™ technology, which provides high efficiency and performance. The frequency response is ±0.25dB from 20Hz to 20kHz, with a signal-to-noise ratio greater than 108dB (A-weighted), and total harmonic distortion of 0.35% at full rated power.
2. One amp shall be used for Speaker (TYPE 1)
3. One amp shall be used for any additional speaker types listed below.

2.13 SPEAKER (TYPE 1)

A. Refer to drawings for locations and quantity.

B. Type 1 speakers shall be Octasound SP860A

1. The loudspeaker shall be an octagonal shaped speaker containing one 18” low frequency driver with a 3” - 8 ohm voice coil and 120 ounce magnet. The speaker shall also enclose four high frequency 9½” x 7¾” wide dispersion exponential compression horns & drivers with 2” voice coils, 1” throat diameter and a magnet weight of 34 ounces. The speaker sensitivity shall be 104 dB per watt per meter and contain a crossover point of 2 kHz ±15% complete with thermal protection and with an impedance of 8 ohms. The speaker shall be manufactured from ¾” wood composite and sealed with an industrial textured finish. Grill shall be plastic and impact resistant. All exposed metal hardware shall be stainless steel or zinc plated. Four 1¼ inch eye nuts shall be provided for mounting. The complete speaker shall weigh a maximum of 120 lbs., with the following dimensions: top width 33”, bottom width 23 ½” and height 16” + 1 ¾” for mounting hardware.

C. Coordinate mounting hardware and secure speaker installation as per manufacturer's recommendations.

D. Include all necessary brackets, eye nuts, and components for suspension installation.

E. Speakers are to be hung via stainless steel aircraft cable, with a minimum of 5:1 SWL speaker weight, break strength.

2.14 SPEAKER (TYPE 2)

A. Refer to drawings for locations and quantity.

B. Speaker shall be Atlas Sound FS12T-66

1. he loudspeaker shall be a weather-resistant, two-way, full-range horn-loaded system designed for high-output speech and music reinforcement in outdoor environments. It shall incorporate a 12" low-frequency driver and a 1" exit high-frequency compression driver, concentrically mounted to a high-directivity waveguide for controlled dispersion. The speaker shall provide a 60° x 60° coverage pattern, ensuring long-throw intelligibility with consistent audio distribution. The system shall feature a 400W transformer for 70V/100V distributed audio systems, with power taps at 400W, 200W, 100W, and 50W, as well as a 4Ω bypass mode for direct low-impedance operation. Constructed from UV-resistant, linear low-density polyethylene (LLDPE), the enclosure shall be IP45 rated for outdoor durability.

C. Include a stainless-steel U-bracket for surface mounting.

D. Coordinate color with architect prior to ordering.

E. All wall penetrations for speaker cable shall be sealed watertight.

2.15 DIGITAL MIXING CONSOLE

A. Digital Mixing Console shall be Yamaha – DM3-D

1. The digital mixing console shall be a compact, Dante-enabled mixer designed for professional live sound reinforcement and integration into a networked audio system. It shall feature 16 mono input channels and 1 stereo input channel, providing a total of 22 mix channels. The mixer shall include 12 motorized faders with layer switching, a 7-inch touchscreen interface, and onboard multi-effects processing

B. Include all necessary cables, connectors, mounting hardware, and accessories for integration.

C. The mixing console shall be initially set up with all routing, initial EQ, balancing, and audio processing already set up for a turnkey installation and setup. The audio operator should only need to do basic channel mixing and minor adjustments to manage the live audio.

D. When the Yamaha DM3-D is connected to the Dante network, all input sources shall be routed via AES67 through the DM3-D for live mixing, while the Extron DMP 128 Plus AT shall function as a pass-through I/O device, ensuring proper signal distribution without processing. In Simple Mode, the Extron DSP shall resume full control of audio processing and routing, automatically reverting the system to an operator-free configuration.

2.16 DIGITAL AUDIO SIGNAL PROCESSOR (DSP)

A. DSP shall be Extron – DMP-128 (Qty-1)

1. A 12x8 digital audio matrix processor with eight mic/line inputs featuring Extron ProDSP™ for advanced audio signal processing. Includes AEC (Acoustic Echo Cancellation) on select models, 48V phantom power, and flexible routing with expansion capabilities via Dante or analog connectivity. Provides configurable EQ, dynamics, delay, and feedback suppression with real-time software control through Extron DSP Configurator.

B. Include all necessary cables, connectors, mounting hardware, and accessories for integration.

C. Balance and calibrate the system in accordance with the required system performance specifications outlined in Part 1 of this document.

D. In Simple Mode, the Extron DMP 128 Plus AT shall function as the primary DSP, handling all audio processing, mixing, and distribution for the system. In Advanced Mode, the DSP shall be configured to receive the main output from the Yamaha DM3-D via AES67/Dante and pass it directly to the amplifiers and other system outputs without applying additional processing. This ensures automated DSP control in Simple Mode and seamless live operator control in Advanced Mode, while maintaining consistent audio distribution across all system endpoints.

E. Coordinate with the Fire Alarm Contractor to integrate the building fire alarm system with the DSP's I/O ports. The fire alarm system shall provide a dry contact closure (NO or NC) to the DSP for triggering an audio mute (ducking) function upon alarm activation. Program the DSP to automatically mute all system outputs when the contact closure is engaged. Verify functionality and test the system in coordination with the Fire Alarm Contractor during commissioning.

2.17 PRESENTER STATION FOR ARENA AV SYSTEM.

A. Refer to drawings for locations and quantity.

B. Coordinate with electrical contractor for rough-in.

C. Touch Screen Wall Control Panel

1. The touch screen wall control panel shall be Extron TLP Pro 1025M Series (Qty (1) Per Presenter Station).

a. 10-inch capacitive touchscreen display with a 1280x800 resolution, 24-bit color depth, LED backlighting, and integrated motion and light sensors for energy efficiency. It supports PoE (802.3af Class 3) for simplified installation and includes built-in audio output.

2. Include all necessary mounting hardware and faceplates.
3. Coordinate color selection with Architect.
4. Minimum features to be controlled are:

a. Display Power On/Off
b. Audio and Video Input source controls.
c. Presentation master audio volume control.
d. System operation mode selection.

5. Contractor shall coordinate with owners representative for a programming meeting to determine the functionality, programmatic use and modes of the touch panel, and setup of initial preprogrammed modes.

D. Wireless Bluetooth Audio Input (Qty (1) Per Presenter Station)

1. Bluetooth input source shall be Radio Design Labs – DD-BTN44.

a. It shall provide bidirectional Bluetooth audio integration into a Dante network, featuring stereo inputs via mini-jack or RCA connections and balanced/unbalanced line-level outputs. The unit shall support a frequency response of 20 Hz to 20 kHz (±0.5 dB) with <0.1% THD+N, allowing Bluetooth device pairing via a single-button interface with LED status indication. It shall be powered via PoE and configurable using RDL Console 2.0 software

2. Coordinate with architect for plate color selection
3. Include all necessary hardware and accessories for wall-mount installation.

E. AVoIP XLR Encoder Wall Input Plates (Qty (1) Per Presenter Station)

1. The XLR input plate shall be Extron AXI 22 AT D Plus.
2. Coordinate with architect for wall plate color selection.
3. Refer to drawings for location and quantity.

F. Wall Plate AVoIP Encoder (Qty (1) Per Presenter Station)

1. Encoder shall be Extron NAV E 201 D

a. The encoder shall be a networked AV-over-IP device designed for low-latency, high-resolution video streaming over a 1GbE network infrastructure. It shall support PURE3® visually lossless compression technology to ensure efficient video transmission while maintaining high image quality. The encoder shall be HDMI-compatible, supporting resolutions up to 4K60 at 4:4:4 chroma sampling with a maximum video data rate of 18 Gbps. The system shall integrate seamlessly with Extron NAV Pro AVoIP solutions for scalable, network-based video distribution.

2. Coordinate with architect for wall plate color selection.
3. Include all necessary mounting hardware and faceplates.

G. Mobile Workstation Link (Qty (1) Per Presenter Station)

1. The mobile workstation link will connect the primary AV switch within the equipment rack located in the MDF room, to the secondary AV switch which is rack mounted within the mobile workstation. The contractor shall provide a Cat6A 10G link from the primary switch to a modular wall jack located at each presenter station, and a 10’ patch cable, to connect the secondary switch to the modular wall jack.

a. The modular wall jack and patch chord shall be yellow in color. Refer to section 27 10 10 - Voice and Data Cabling Distribution System, for cabling specifications and requirements.
b. The Category 6A link connection between

2.18 CAMERA STATION

A. Refer to drawings for locations and quantity.

B. Coordinate with electrical contractor for rough-in.

C. Wall Plate AVoIP Encoder (Qty (1) Per Camera Station)

1. Encoder shall be Extron NAV E 401 D (Qty-1)

a. The encoder shall be a networked AV-over-IP device designed for low-latency, high-resolution video streaming over a 1GbE network infrastructure. It shall support PURE3® visually lossless compression technology to ensure efficient video transmission while maintaining high image quality. The encoder shall be HDMI-compatible, supporting resolutions up to 4K60 at 4:4:4

chroma sampling with a maximum video data rate of 18 Gbps. The system shall integrate seamlessly with Extron NAV Pro AVoIP solutions for scalable, network-based video distribution.

2. Coordinate with architect for wall plate color selection.
3. Include all necessary mounting hardware and faceplates.

D. SDI Wall Plate

1. Refer to Refer to 27 41 10 - General Requirements for Audio-Visual Systems for Wire and Cable Specifications for SDI cabling and wall plate jack specifications.

2.19 MICROPHONES

A. Wireless Microphone System

1. Wireless Microphone System (Head-worn Microphone)
    a. Shure QLXD14 Body Pack System QLXD1 wireless bodypack transmitter and QLXD4 Wireless Receiver (Qty-2)
    b. Shure SM35 Head Set Microphone with cable for QLXD1 transmitter (Qty-2)
    c. Select proper channels for each system so that there is no interference with other wireless microphone system channels nor other wireless systems within the building.
    d. Include antenna, rack kit, power supply, and battery chargers.
2. Wireless Microphone System (Handheld Microphone)
    a. Shure QLXD24/SM58 System, including QLCD2/SM58 Handheld microphone/transmitter and QLXD4 wireless receiver (Qty-2)
    b. Mount antenna remotely within the arena to enable complete coverage throughout the entire arena.
    c. Select proper channels for each system so that there is no interference with other wireless microphone system channels nor other wireless systems within the building.
    d. Include antenna, rack kit, power supply, and battery chargers.
3. Remote Receiving Antenna And Multiplexer (Antenna Type 2 – Refer to drawings)
    a. Shure UA844+SWB Antenna Distribution System (include all necessary cabling, power supply, connectors, adaptors, etc.)
    b. Shure UA874 Active Directional Antenna (include all necessary, wall mounting kit, power supply, hardware, cable, connectors, etc.)
    c. Mount antenna remotely within the arena to enable complete coverage throughout the entire arena.
    d. Refer to 27 41 10 - General Requirements for Audio-Visual Systems for antenna Cable standards.
4. Wired Microphones
    a. Wired microphones shall be

2.20 ASSISTIVE LISTENING SYSTEM

A. Assisted Listening System (Antenna Type 3 – Refer to drawings)

1. Listen LS-55-072 Listen iDSP Prime Level III Stationary RF System (72 MHz) – (Qty 1)
    a. Furnish and install an RF wireless assistive listening system for use by the hearing-impaired. The assistive listening system (ALS) shall be capable of broadcasting on 57 channels and be frequency agile. The RF receiver shall be capable of receiving on 57 wide and narrow band

channels. The device shall tune to a single channel and user shall not be able to change the channel. The receiver shall have a signal-to-noise ratio of 80 dB or greater and shall have an audio frequency response of 50 Hz – 15 kHz (±3 dB). The device shall employ a unique DSP SQTM noise reduction technology. The unit shall have a programmable squelch circuit. The unit shall incorporate a multi-functional display that indicates battery status, inventory number and channel. The device shall have the option of being lanyard or belt clip worn and the lanyard shall have the option of an integrated DSP driven neck loop that automatically senses and sends optimized audio signals directly to hearing aids and cochlear implants equipped with telecoils. The neck loop shall have a field strength of 400 mA/m (+/- 3dB) and frequency response of 100Hz to 5kHz (+/- 3 dB ref 1kHz). The device shall have a USB connector used for inventory control, set up, charging and firmware upgrades. The device shall incorporate automatic battery charging circuitry and use a non-proprietary lithium ion battery. The device shall have additional charging contacts to allow multiply charging options. The ALS system shall have 80dB SNR or greater, end-to-end. Listen Technologies Corporation products are specified.

b. Furnish and install the following:

1) Listen Technologies LT-800-072-01 Stationary RF Transmitter (72 MHz) (Qty: 1 ea.)
2) Listen Technologies LA-122 Universal Antenna Kit (72 MHz and 216 MHz) (Qty: 1 ea.)
3) Listen Technologies LA-326 Universal Rack Mounting Kit (Qty: 1 ea.)
4) Listen Technologies LR-4200-072 Intelligent DSP RF Receiver (72 MHz) (Qty: 4 ea.)
5) Listen Technologies LA-401 Universal Ear Speaker (Qty: 4 ea.)
6) Listen Technologies LA-430 Intelligent Earphone/Neck Loop Lanyard (Qty: 2 ea.)
7) Listen Technologies LA-LA-381-01 Intelligent 12-Unit Charging Tray (Qty: 1 ea.)
8) Listen Technologies LPT-A107-B Dual RCA to Dual RCA Cable 6.6 ft. (2 m) (Qty: 1 ea.)
9) Listen Technologies LA-304 Assistive Listening Notification Signage Kit. (Qty: 1 ea.)

2.21 WIRE AND CABLE

A. Refer to 27 41 10 - General Requirements for Audio-Visual Systems for Wire and Cable Specifications.

PART 3 - EXECUTION

3.1 GENERAL

A. All materials and equipment proposed by the Contractor must be new and unused. Equipment refers to all hardware, cabling, materials and incidentals, etc.

B. The owner reserves the right to waive any procedural requirements set forth herein for any and all Sound Contractors

C. Install sound system components and products as indicated, in accordance with applicable requirements of NEC and in accordance with recognized industry practices to ensure that products serve the intended function.

D. Furnish components, racks, wire, cabinetry, connectors, materials, parts, equipment and labor necessary for the complete installation of the systems, in full accordance with the recommendations of the equipment manufacturers and the requirements of the drawings and specifications.

E. Installation shall follow standard broadcast wiring and installation practice, and shall meet or exceed industry standards for such work.

3.2 INSTALLATION

A. This Section includes installation requirements of the Integrated Audio-Video. If you have any questions regarding the intent or application of any feature, submit these questions to the principal contact for this

project, as indicated in Division 00. This section covers the general requirements for the installation of the equipment by the Contractor.

1. All work shall be done in a thorough and conscientious manner according to industry standards and shall be subject to inspection and acceptance.
2. The Contractor shall be certain that all installation work areas are secure and made safe in accordance with Occupational Safety and Health Administration (OSHA) regulations.
3. An appropriate construction schedule shall be developed by the Contractor and will be subject to approval by the customer's representatives. The construction schedule should include at least one installation supervisor, or lead technician, for on-site management of the project.
4. Prior to starting the installation, the assigned installation supervisor, or lead technician, shall participate in a "walk-through" of the project location with the customer's representatives to review the installation documentation, verify that all construction necessary for the installation has been completed, and verify all installation methods and cable routes.
5. The Contractor shall be responsible for completing a standardized report form addressing the weekly progress of the installation schedule.
6. The Contractor shall maintain conductor polarity identification at the main equipment room, backbone, and horizontal connections in accordance with industry practices.
7. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the system.
8. The Contractor shall be responsible for labeling all cable, distribution frames, and out- let locations, according to industry standards.
9. It shall be the responsibility of the installation Contractor to furnish any special installation equipment or tools necessary to properly complete the installation.
10. The Contractor shall not roll or store cable reels without an appropriate underlay.
11. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
12. The Contractor shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during the placement facilities. Failure to follow the appropriate guidelines may require the Contractor to provide additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation Contractor during the implementation.
13. The Contractor shall plug conduits where cabling has been installed by the installation Contractor in the equipment rooms, backbone and other cable entrance locations with re-enterable duct seal of flame-retardant putty.
14. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment are required, these units shall be the product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.
15. Wiring, materials, and equipment will be delivered and stored in a clean dry space. They will be properly packaged in factory fabricated type containers and protected from damaging fumes, construction debris and traffic until job completion.
16. The wiring, materials, and equipment furnished for this request shall be essentially the standard product of the manufacturer.
17. All installation techniques and fixtures shall result in ease of maintenance and ready access to all components for testing measurements. All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be used unless specifically approved by the customer's representatives. All parts shall be made of corrosion resistant material, such as plastic, anodized aluminum or brass. All materials used in installation shall be resistant to fungus growth and moisture deterioration. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.
18. The Contractor will submit for approval, a detailed description of the procedures and equipment included for the complete operational installation.

B. Control Systems

1. Contractor shall meet with owner and whomever the Owner deems appropriate to dis- cuss control features and navigation. Once agreement is received on the control navigation, the Contractor shall submit detailed documentation and GUI configuration and programming for approval. This process will continue until the contractor obtains documented approval from the Owner for control design. Contractor shall provide reasonable hours for changes once the system is operational to ensure the

Owner's satisfaction. The control software shall be delivered to the Owner upon substantial completion of the project.

C. Wiring Plan Requirements

1. Distribution of the cabling will be accomplished through cable trays, conduit raceways, ducts, core-holes, extended columns, false half columns and plenums. Cabling shall be run at right angles from cable trays. Horizontal cable segments will be placed in cable trays and with cable exits/entrances supported by distribution rings or J Hooks. Cable may not rest on ceiling tile, be supported on existing ducting, tied, or supported by fire alarm, security or electrical infrastructure nor interlaced with existing cable.
2. The Contractor shall be responsible for providing an approved ground at all equipment locations. The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and frameworks. All grounds shall consist of a minimum of 12 AWG copper wire or larger as required by code and shall be supplied from an approved building ground and bonded to the main electrical ground.
3. Observe proper circuit and loudspeaker wiring polarity. Properly and clearly label connections and wires as to function and polarity. No cables will be wired with polarity re- versal between connectors, at either end. Take care when wiring microphone cables to ensure that constant polarity is maintained.

D. Speaker Placement and Optimization

1. The Contractor shall be responsible for the precise placement and aiming of all loudspeakers based on field verification of the installed conditions, speaker coverage patterns, and acoustic characteristics of the space. The Contractor shall ensure that all speakers are positioned and tuned to provide full, even coverage across the designated listening area, minimizing dead zones, reflections, and excessive overlap. The system shall be balanced and equalized to optimize clarity, intelligibility, and uniform response, ensuring consistent SPL levels appropriate to the application. Final adjustments shall be made in coordination with the Owner's representatives, with all settings documented and submitted as part of the project closeout

E. Cable Management

1. Maintain segregation of cables. AC power cables or speaker cables should not be run parallel within proximity to signal wires (within 2"), unless the wires are twisted.
2. The bend radius for twisted-pair cables is standardized at 12" (3" diameter).
3. Bundle cables within the guidelines of 2005 National Electrical Code (NEC) in Article 310.15(B)(2).

F. Rack Dressing

1. All Racks require Lacer Bars or Strips to provide clean cable management with ing the rack.
2. All racks require the cable segregation of AC cables, Speaker Cables, low impedance balanced cabling and twisted pair cables.
3. All AV Racks should be assembled and tested at the Contractor's facility and trans- ported to the job site when possible.
4. No Cable Ties; Velcro only.

G. Identification, Labeling and Documentation

1. The Contractor shall label all termination devices, panels, enclosures and equipment rooms. The Contractor will mark each unit with permanently attached, self-laminating markings that will not impair the equipment or present a hazard to maintenance personnel.
2. Place wire identification numbers on each end of all conductors. Install markers to be readable from left to right or top to bottom. Wire numbers shall be computer printed. Handwritten labels are not acceptable.
3. Mark all spare conductors and coiled neatly located at the bottom of the equipment rack.

3.3 TESTING REQUIREMENTS

A. The Contractor shall perform sample tests in the presence of the customer's representatives. Performing the testing procedures specified herein assures that the equipment and interconnection meets the performance characteristics specified. If testing indicates that the performance characteristics are not met, the test shall be declared a failure. The communication equipment and interconnection cabling shall

be modified and/or repaired accordingly. The failed test and any other test that may be affected by the modification and/or repair shall be rerun. After all components have been installed, the integrity of the equipment and interconnection cabling shall be verified.

B. If system test fails because of any component(s) in the system, the failed component(s) shall be corrected or substituted with other components and the tests shall be repeated. If a component has been modified because of the system test failure, a report shall be prepared and delivered to the customer's representatives prior to retesting. The Contractor shall prepare and submit all test procedures and data forms for the post installation and system test to the customer's representatives.

C. The test report shall contain the description of all tests performed, the results obtained, and any required adjustments or modifications necessary because of testing and installation. This report shall reflect the as-built communication equipment and interconnection cabling. An authorized representative of the Contractor shall sign the test report. At least three copies of the test report shall be sent to the customer's representatives.

1. Sample Test Report:

ITEM	ROOM/AREA	INPUT / OUTPUT	SOURCE	TEST RESULT	RECOMMENDED CORRECTIVE ACTION
1	Arena	AV-01 HDMI IN	Tech Laptop	No image displayed.	Verify HDBaseT connectivity on 12/25/19.

D. The test procedures shall have the Owner's representative's approval before the tests.

E. Contractor shall demonstrate to the Owner's representatives that the equipment operates as specified and that the tests meet performance requirements.

F. The Contractor shall ensure that the equipment is in first-class working condition and free of short circuits, ground loops, parasitic oscillations, excessive hum, RF interference, or instability of any form.

G. The Contractor shall test each operational component and adjust for equal sound levels at a given volume setting and replace defective items.

H. The contractor shall ensure that all loudspeaker and distributed audio systems described herein are balanced and optimized for maximum quality sound and coverage of listening areas.

3.4 TRAINING

A. System training shall be provided for the operator/user and technical staff.

1. Operator/user training shall be held at the Owner's convenience and to the Owner's satisfaction.
2. Technical operation and maintenance training shall be held at Owner's convenience and to the Owner's satisfaction.
3. The Contractor shall provide documentation demonstrating the Owner and/or Owner's Representatives understand the operation and maintenance of the system.
4. Complete operation and maintenance manuals and preliminary as-built drawings shall be delivered to the Owner one week prior to training sessions.

B. Operator/user training shall minimally consist of:

1. Provide printed reference material for each trainee that documents and explains in layman's terms:
   a. System block diagram
   b. Normal day-to-day operation
   c. Operator selectable features
2. Provide a hands-on training with Q & A session

C. Technical Operations and Maintenance training shall consist of:

1. The technical explanation shall be sufficiently thorough that staff personnel shall be able to make any programming changes required, analyze malfunctions and make equipment substitutions or bypasses necessary to maintain system operation except for the malfunctioning equipment or circuits.
2. Provide printed reference material for each trainee that documents and explains in technical terms:

    a. System block diagram with technical features
    b. Technical operation, adjustments and programming
    c. System features and programming
    d. Review of as-built drawings.

3. Provide hands-on training with Q & A session.

D. The contractor will provide a complete and comprehensive list of the maintenance schedule for all installed and/or provided equipment.

3.5 ACCEPTANCE OF SYSTEMS

A. Specifications set forth for construction of the system have been devised to ensure system compatibility and performance. Compliance to these specifications will be determined during periodic observances of construction. Repeated failure to comply with the specification will be considered before the initial acceptance phase of the plant commences.

B. Prior to Contractor performing final testing, deliver preliminary as-build documents to Owner for use in conducting testing observation.

C. Project Record Documentation

1. Upon completion of final engineering and incorporation of the Architect review comments, Contractor will provide to the Architect for its records the following close out documentation:
2. Record or As Built Drawings which shall include but not limited to:

    a. Functional block diagrams for each Integrated Audio-Video System
    b. All Integrated Audio-Video or Audio-Visual junction box locations
    c. Audio Visual equipment rack locations
    d. Rack elevations

        1) Rack elevations shall show all components as installed under this contract.
        2) Contractor will label each component describing the component. (Examples: Arena DSP etc.).

    e. Floor plan drawings with device locations and associated assigned item number.
    f. Mounting detail for equipment and hardware.
    g. Schedule of all devices with associated panel termination, zoning, power circuits, etc.
    h. Corrected product submittal information

3. A complete inventory list of installed products shall include:

    a. Manufacture Name
    b. Model Number
    c. Serial Number
    d. Room number and/or description of installed location

4. Operation and Maintenance Manuals shall include

    a. Include detailed procedures for system operation that begin with startup procedures and continue through system shut down referenced in section 3.3 Training.
    b. List of manufacture recommended maintenance and intervals with manufacture support contact information.

D. Drawings will contain the Contractor's own title block on the edge of the drawing. The title block shall contain the following information and adhere to the following requirements:

1. Company name
2. Company address and phone number for service
3. Date on the drawings will match the date of acceptance for warranty purposes
4. Do not use any part of the consultant / architect title block, copyright data or seals. Failure to remove these items will result in the document being returned stamped re- vise and resubmit.

E. Drawing documentation will be in the following format:

1. One (1) electronic copy transmitted to the general Contractor through their approved transmittal process.
2. Drawings will be in PDF format.
3. File transfer is acceptable.

F. Drawings shall be provided to the architect two weeks prior to the final testing and commissioning of the system. Coordinate with the Owner during the pre-construction meeting for low voltage Contractors to schedule this delivery date.

G. The drawings will be reviewed on site with the architect and the Owner prior to the final acceptance process. Drawings rejected for any reason will delay the final acceptance process until resolved.

H. Testing Results

1. In addition to the project record drawings, the Contractor shall provide the testing in- formation for all audio-visual cabling.
2. Test results shall be provided to the architect two weeks prior to expected final acceptance of the system(s). Coordinate with the Owner during the pre-construction meeting for low voltage Contractors to schedule this delivery date.
3. The drawings will be reviewed on site with the architect and the Owner prior to the final acceptance process. Test results rejected for any reason will delay the final acceptance process until resolved.

I. Once accepted by the architect and Owner all documentation / program code becomes the property of the Owner

J. Within ten days of receipt of the final acceptance notice, the Owner's representatives shall schedule and perform the final inspection. When the work is found acceptable under the contract documents and the contract is fully performed, declare substantial completion of the project.

3.6 WARRANTY

A. The Contractor shall warrant and guarantee all work against defects in material, equipment or workmanship for one (1) year from the date of substantial completion of the entire project.

B. Upon receipt of written notice, Contractor shall remedy defects within thirty (30) days, or the Owner shall correct the defects and the Contractor, or its surety shall be liable for expenses.

END OF SECTION

SECTION 27 51 23

INTEGRATED ELECTRONIC COMMUNICATIONS AND CLOCK NETWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. 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 - Boxes for Electrical Systems
6. 27 10 10 - Voice and Data Cabling Distribution System
7. 27 05 00 - Common Work Results for Communications
8. 27 41 10 - General Requirements for Audio-Visual Systems

1.2 SUMMARY

A. This section includes a fully operational IP platform for a district-wide internal and school Critical Communications Solution, incorporating school safety notifications and general communications including but not limited to the following:

1. The platform shall provide complete internal communications and employ state-of-the-art IP Technology including the minimum functions listed.
    a. Analog all-call paging zones are as follows:
        1) Both Buildings – All Call
        2) Arena Building – All Call
        3) Animal Barn – All Call
    b. Emergency announcements that will override any pre-programmed audio, assuring that all Emergency/Lockdown etc., are heard at speaker locations.
    c. Capability of prerecording emergency announcements that can be activated by a Soft Key on an administrative console, panic button, dial string, mobile app, or web browser.
    d. programmable schedules for each zone.
    e. District-wide, Emergency, Group, All School and Zone live voice paging.
    f. District-wide, Emergency, Group, All School and Zone paging for pre-recorded audio – tones, music and voice.
    g. Single sign on web-based user interface for multi-school functionality.
2. The system shall support a minimum of 1000 level priorities which shall be user-definable, allowing each end point to place a minimum of 5 different priority calls at the same time.
3. Any authorized administrator shall be able to call from outside the school into any classroom, zone, or entire school directly via the School District supplied SIP enabled Telephone Network. This shall allow remote monitoring, call-in annunciation, and two-way conversation from outside the facility as well as paging into the system. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools).
4. Authorized system users shall be able to create a minimum of 100 automated sequences with voice instructions, tones, emails, program distribution, and relay activations and replay them.
5. Automated message strings shall be manually initiated from single-button access on the console, on a SIP connected telephone, panic button, mobile app, from the web-based user interface or via interface with third party systems.

6. Paging and two-way intercom features shall be accessible from any system console or SIP connected telephone for each campus.
7. The platform shall synchronize its system time to the network timeserver or a web-based time server.
8. Each single campus installation shall be locally survivable for intercom, paging, bells, and emergencies such as lockdown, even when the district connection is unavailable.
9. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.
10. Systems that do not comply with the feature-sets highlighted in this Specification will not be considered.
11. Included in the emergency procedures is the ability to send specific messages and or instructions. These features can be added to the emergency sequences.
12. The ability to require an access code to initiate or clear an emergency from the administrative console.
13. An app that can run on either Android or Apple phones. This app will give the user the ability to initiate one of 18 emergency procedures programmed into the app. This app will also allow you to view all classrooms check in status. This process will update during the emergency to make sure all information is current.
14. The ability to allow the fire alarm system to signal an active fire alarm to TCU. This will allow supplemental visual and audio messaging from Telecenter U. Telecenter U can be programmed to change system state, dependent on the active emergency. Both fire and emergency will be displayed on the administrative console and mobile application.
15. Any system that requires more then one Cat drop to a classroom to control an IP speaker, up to 5 call-in switches, status lights (up to 2) and message board/digital clock will not be considered equal to the specified system.

1.3 DEFINITION OF TERMS

A. Installer(s): Shall refer to the person, persons, or company who or which contracts to perform the work specified herein.

1.4 SUBMITTALS

A. Product data for each component.

B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, location of each field connection, and a complete schedule of all equipment and materials with associated manufacturer’s cuts sheets which are to be used.

   a. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
   b. Artwork drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
   c. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor’s name in the title block.
   d. Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

D. Maintenance Data: For equipment to be included in maintenance manuals specified in Division 1.

   a. Record of Owners equipment-programming option decisions.
   b. All instructions necessary for proper operation and manufacturer's instructions.
   c. "Proof of Performance" information.
   d. Manufacturer's maintenance information.
   e. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.

E. Record Drawings: Prior to final acceptance, provide three (3) complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing".

F. System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with Division 1 specifications.

   a. Include with the submittal a preliminary staff development training program in outline form for review and approval by the owner's representative.
   b. Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
   c. Include with the submittal a current copy of trainer's needs assessment form which will be reviewed with the owner's designated representative for the system's preliminary system programming and configuration.
   d. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.

G. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required **five-year** warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced Installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within thirty (30) days after notification to proceed:

   1. Provide a list of installations that the Installer has specifically installed for verification by the Owner. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.
   2. The Installer shall be bondable.
   3. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:

      a. Adequate plant and equipment to pursue the work properly and expeditiously.
      b. Adequate staff and technical experience to implement the work.
      c. Suitable financial status to meet the obligations of the work.
      d. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.

B. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of an "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to

the Architect/Engineer. The “Installer” shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer.

C. Because the life expectancy of this type of communications structure normally exceeds 10 years, the owner expects continuity from the service provider. If the installing/servicing company has not been an authorized provider of the manufacturers product for it least (5) years, the following is required:

1. A list of (2) systems manufacturers of which they currently are authorized service providers where the relationship exceeds (5) years.
2. A letter from the manufacturer outlining the details of changes in service providers over the last (3) years and what actions they will take to ensure continuity of service to the customer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

E. Comply with NFPA 70

F. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.

G. Comply with UL 60950.

1.6 IN-SERVICE TRAINING

A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.

B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.

C. All staff development training is to be coordinated through the owner’s designated representative. As training sessions are completed, the trainer will provide the school’s administrative staff and school district’s staff a document listing all the staff and faculty members who attended, received, and completed the training program.

1.7 WARRANTY

A. Provide a **manufacturer’s five-year warranty** of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic system components. Additional warranties cover clocks, speakers, and call in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one-year warranty shall be provided for labor.

B. A copy of the manufacturer’s standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer’s stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special “extended warranties” that are not part of their normal published warranty will not be accepted.

C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide “loaner” equipment to the facility at no charge.

D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

1.8 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide the following system:

1. Telecenter manufactured by Rauland

a. Authorized Rauland Distributor contact:
b. Lone Star Communication
c. 1414 Post & Paddock, Suite 200
d. Grand Prairie, TX 75050
e. John Borden
f. jborden@lonestarcom.com

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. The platform shall utilize state of the art IP Technology for Emergency automation, Call-in Notification, School Safety Paging and Evacuation tones, Class Change Tones utilizing multiple, programmable schedules for each zone, two-way hands-free everyday internal communications and paging, visual messaging, and program distribution. The system shall be easy to learn and operate. All standard programming shall be web-based, district-wide and user friendly to allow the system administrator the ability to easily program system features.

B. Provide complete and satisfactorily operating district/school communications and district/school safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

C. The platform shall be a single electronic system consisting of a minimum of 10 audio channels for each campus, (classroom) IP Speaker Modules and call switches, IP Zone Modules connecting corridor speakers, inside and outside horns, IP Administrative Consoles, SIP enabled PBX integration and district-wide integration for paging, emergency notifications, calendar scheduling and configuration.

D. Each Classroom shall be provided with a Speaker Module interface, a status light, and a minimum of 5 different call switches, each with their own annunciation path and priority.

E. Call-ins may automatically annunciate (display of priority and location) to administrative consoles, SIP enabled phones, and outside phones.

F. Call-ins shall be programmed to automatically change priority and annunciation route based on age of call-in and original priority.

G. Call-ins may have priority (and annunciation route) changed by user action from a console or SIP enabled phone.

H. Call-in annunciation route shall include playing pre-recorded audio over speakers, sending a pre-configured email, and activating relays.

I. The platform shall lend itself to expansion by simple addition of hardware modules.

J. The platform shall connect directly to a, standard protocol WAN/LAN network, without the need for a separate server at each school location. Configuration, including bell schedules, calendars, and emergency sequences can be remotely created, changed, stored and downloaded to the system by an authorized user from a web-based user interface. The WAN/LAN network cabling platform will be provided by the owner under a separate contract. The communications system installer must carefully coordinate all required IP network data drops required for their systems to be fully operation with the network cabling system installer.

K. The platform shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone or connected web browser within the facility or outside the facility to any other location within the facility or district.

L. The platform shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands-free and will not require any interaction by the classroom user.

M. The platform shall provide classroom users the ability to confirm that they have safely secured their classrooms during an emergency with a single button press. The front office administrator will receive confirmation that the classroom is safely secured via an administrative console and web-based user interface. The front office administrator can view classrooms that are not safely secured via the administrative console. The front office administrator can view classrooms that are not safely secured via the web-based user interface. The front office administrator shall be able to initiate two-way communication, without a pre-announcement tone, to the classroom during an emergency via the administrative console. Web-based user interface will still identify that a school is in an emergency, even if all classrooms are safely secured. Individual classroom check-in and school emergency status shall be viewed from the web-based user interface, both on-site and remotely.

N. IP Addressable and POE powered Speaker Modules for individual rooms shall be system programmable and may be assigned any two, three, four, five- or six-digit number as well as name and description. Any extension may be reassigned at any time.

O. IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in a campus. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation. Pre announce tone and supervisory tones shall be disabled during designated emergencies automatically.

P. The platform shall allow users to configure multiple schedules per school, with a minimum of 500 unique events per schedule, and automatic Daylight Savings time correction. Schedules can be programmed to occur once, daily, weekly, monthly, or in any combination of the preceding recurrences. Each school may have a minimum of 20 unique bell schedules, with a minimum of 5 active schedules on any given day for each campus. User shall be able to select from 25 standard included tones as well additional user created and uploaded audio files for class change signaling and messaging. In addition, scheduled events shall include relay actions, email notifications, visual messaging, status lights and paging exclusions as system configuration changes. The platform shall allow control of the bell schedules via the district WAN/LAN without the need for a separate server at each school location. Bell schedules can be remotely created, changed, stored and assigned to calendar days for the local school by an authorized user from a single web-based user interface, without logging into multiple systems.

Q. The platform shall be able to integrate with an existing PA system or operate as a fully independent IP solution. The platform shall be able to function in combination of said configurations and allow for seamless communication within a school or district-wide, regardless of the type of configuration used. The platform shall be scalable, with the ability to easily add, install, and configure additional equipment to a system.

R. The platform allows for customization of preprogrammed sequences, used for emergencies, events, and everyday communications. Preprogrammed sequences can be activated from the push of a relay button, soft key of an administrative console, a dial string of a SIP phone, or a web browser configured to the district network. Sequences can be initiated automatically as part of a schedule or on the fly. Preprogrammed sequences can be customized to utilize any combination of audio tones, emails, relays, tone exclusions, swings, delays, duples, SIP phone notifications, and program distribution. Audio tones can include customized audio files and voice messages, recorded in any language. Uploaded audio tones and messages can be preprogrammed to annunciate repeatedly or individually, as part of a scheduled sequence or on the fly. Each school in a district can have its own customized sequences, and can be activated individually, in groups, or district-wide.

S. The platform allows for emergencies to be initiated in a drill environment, separate from real emergencies. Drill emergencies can be initiated from panic buttons, consoles, SIP phones, or a web browser.

T. The platform shall provide status lights that will display the status of individual classrooms and school-wide status, including for emergencies, at the same time. Status lights will be customizable in color and flash rate based on event type and priority.

U. Visual message boards are available in 2 sizes. Small message boards have 8 by 40 LED display with 3 color LED’s. The large message board will have 2 lines with 16 by 80 LED display with 3 color LED’s. During idle time the message boards can display date and time. They can also display countdowns for class change or status of an emergency. You will have the ability to change the messages on the fly to display instructions or directions. Status lights can be tied to message boards to give more information as to status of classrooms that checked in or groups of rooms that checked in.

V. POE zone page amplifier module. This component will give the schools the ability to play audio to drive groups of speakers from a single device. Depending upon configuration you can have 14 or 35 watts of output. The module can be either wall or rack mounted.

W. First Responders Notification. This feature can be initiated so the status lights do not display the rooms that checked in until the first responders are on site. This will not influence any of the other check-in notifications. The App, console and computers can still display the rooms that checked in.

X. TCU Emergency Initiation App. This app can be installed on either Android or Apple devises. The app can process up to 18 different emergencies. The app will update in real time rooms that have checked in OK. It can also display a Fire emergency is in effect during an emergency.

2.2 EQUIPMENT AND MATERIAL

A. Server Software

1. Provides district-wide paging, bell event scheduling, emergency notification and configuration for entire district.
2. Ability to configure system and initiate system features, per school and district-wide via web-based user interface.
3. The software can sync system time to the Atomic Clock Signal or to the school’s or district’s network time server.

4. The software will provide a web browser to deliver district-wide emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The software must be capable of automatically notifying district personnel via the WAN/LAN of an alarm condition.
5. The software can automatically broadcast emergency instructions via associated system hardware throughout an entire district when an alarm (e.g. lockdown, lockout, security, fire) is initiated via the web-based user interface. The emergency instructions are preprogrammed and require no user intervention. Bell tones can be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
6. The software allows for user-uploaded pre-recorded messages and tones. Software supports the upload of MP3 and WAV file types. User-uploaded pre-recorded messages and tones can be part of emergencies, sequences, and bell schedules.
7. The software can be installed in cloud, virtual or physical server environments.
8. The web-based user interface supports secure HTTP browsing.
9. The software supports encryption to ensure secure access.
10. The system shall monitor itself if devices go offline and system actions are not received. Specified users shall receive email notifications when devices go offline. The software shall be able to keep a log and report on system activity within a school or all schools district-wide for a minimum of one year. These reports can be exported to excel spreadsheets.
11. The system shall allow administrators to run reports on all system activities including emergencies, drills, paging, call-ins, check-ins and system trouble on a per school, multi-school and district-wide basis.
12. The software will support a minimum of 20 bell schedules per school, with 5 schedules assignable to a specific school day. Bell schedules can be programmed to annunciate tones, activate relays, send emails, activate program distribution, and notify SIP phones.
13. The system allows programmable end points to be automatically included or excluded for live paging, bell tones, or prerecorded audio, depending on the time or day or day of the week. These inclusions/exclusions can be applied manually or automatically depending on their schedule.
14. The software can automatically send an email, as part of a programmed sequence of events, to district administrators alerting them of an emergency within the district.
15. The software provides the ability to view schools that are in an emergency status, using any web browser on the district's network. The software shall identify the name of the school in an emergency as well the type of emergency that school is in.
16. The software provides the ability to view individual classrooms that are not checked-in during an emergency, using any web browser on the district's network. The software shall identify the name, extension, and description of the classroom that is not checked-in during the emergency.
17. The system has a minimum of 5 customizable emergencies, one of them being an All-Clear – with the ability to return the system from an emergency to normal status. Each emergency shall have a minimum of 500 unique events.
18. As a district-wide communications solution, the system shall be able to provide simultaneous communications to all schools or groups of schools within a district. The system shall allow a user to initiate district-wide communications to individual schools, all schools or groups of schools, from a web-based user interface. The system shall allow a user to initiate prerecorded audio, live paging, or programmed sequences to individual schools, all schools or groups of schools, from the web-based user interface. Programmed sequences shall be customizable per school, and the system shall be able to activate them simultaneously to individual schools, all schools or groups of schools, from the web-based user interface.
19. The communications software must allow upgrade from an individual school system to multiple schools, or an entire school district, using the same web-based user interface. The communications software from an individual school system must be identical in typical user operation to the multiple schools or entire school district communications system software.
20. The system allows for emergencies to be initiated as drills for practice. Drills may include all or some of the associated steps as its corresponding emergency sequence. Drills are recorded in the event history report.
21. The system provides the ability to export lists of bell schedule steps, emergency sequences, staff directory, users, peripherals, and zone targets.

B. Campus Controller

1. Provides call routing for paging and intercom for a single facility.
2. System shall connect to the district provided Telephone Network via a SIP connection.
3. Support a flexible numbering plan allowing two, three, four, five, or six-digit extensions.
4. SIP interface to a district provided Telephone Network shall be capable of allowing connected phones to display classroom call-ins, answer internal intercom call-ins, make pages and change priorities of call-ins in progress.
5. Direct dialing, two-way amplified voice intercom between any provided telephone or admin console and speaker without the use of a press-to-talk or talk-listen switch.
6. Ability to upgrade priority level from individual call switch.
7. The ability to answer intercom call-ins registered at administrative consoles and pre-selected telephones.
8. The ability to automatically escalate incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.
9. The ability to manually upgrade an intercom call-in to an alternate telephone or group of telephones.
10. The ability for classrooms to “check-in” via push button when they have successfully secured their location during emergency.
11. Administrative console shall display locations that have not checked in to confirm their secured location and provide hands-free audio monitoring and communication to unsecured locations.
12. The controller shall not need direct connection to any classroom via home run or distributed wiring. It shall communicate solely through the IP network.
13. Single button access from any console on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative console shall have priority over all regular system functions.
14. Ability for administrative consoles and connected phones to selectively monitor audio at any two-way speaker during an emergency.
15. Stores a minimum of 48 hours’ worth of Bell Event Schedules, all emergency notification sequences as well as facility wide configuration.
16. System can sync system time to the Atomic Clock Signal or to the school’s or districts network time server.
17. System’s SIP Interface shall provide:
    a. Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
    b. Ability to answer a call-in directed to that SIP extension.
    c. Ability to upgrade a call-in directed to that SIP extension.
    d. Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.
    e. Ability to initiate a school-wide emergency including lockdown and evacuate sequences.
    f. SIP device shall display call-in information from call in switch. Information will include a minimum of Classroom Name, Number, and Priority Level.
18. The system will have the ability to utilize a web browser and a USB microphone connected to the PC to deliver district-wide live emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
19. The system will have the ability to utilize a desktop microphone to deliver school-wide live emergency paging and zone paging throughout the facility.
20. The system can automatically broadcast emergency instructions throughout an entire campus when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user

intervention. Bell tones can be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.

21. The system can integrate with emergency weather radios to generate live emergency broadcasts notification throughout a facility.

C. IP Addressable Modules:

1. System shall provide multiple IP Addressable Modules for intercom, paging and relay activation.
    a. All Modules are POE 802.3af compliant
    b. All Modules support DHCP.
    c. All Modules connect to network with a single RJ45 connector
2. IP Addressable Speaker Module
    a. Shall interface to school's data network, a classroom speaker, and multiple call switches.
    b. A minimum of 5 levels of call-in can be placed from an IP Speaker Module. The call-ins are routed to administrative consoles and select SIP connected telephones and can only be cleared from the system once answered. If a call-in is not answered within a preprogrammed time the call-in may reroute to other telephones, consoles, and speakers.
    c. An option for Privacy call in switches is supported. When the Privacy switch is activated it prevents administrative or classroom telephones from monitoring the specific classroom/location intercom speaker.
    d. The ability to belong to one or more of a minimum of 100 independent zones for zone paging, program/music distribution zones and class change tone zones; this assignment is a programmable function, changeable by time of day. Each IP Speaker Module's location shall be programmed in software to belong to any combination of software zones. IP Speaker Modules shall be designed to mount near ceiling and wall speakers and in the plenum space.
    e. Intercom and paging volume adjustable from Software interface.
    f. Module will support and power a status light that displays individual classroom information including call-ins placed, testing status and emergency check-in status.
3. IP Addressable Zone Paging Module
    a. Zone Paging Module shall connect multiple speakers for district all page, all page, zone paging, bells, audio events and, emergency notification.
    b. Zone Paging Modules shall be rack and wall mountable.
    c. Zone Paging Modules shall be able to belong to one or more of 100 independent zones for live paging, bells, pre-recorded audio and emergency notification.
4. IP Addressable Aux I/O Module
    a. Aux I/O Module shall have two input contacts and two output contacts.
    b. Input and output contacts are individually addressable.
    c. Aux I/O Module shall be wall and rack mountable.
    d. User can program relays to be activated manually, through an event/bell schedule, or during emergency notification.
    e. Aux I/O Module can perform school lockdown from a single press of a panic button.
5. IP Addressable Program Line Input Module
    a. Program Line Input Module shall provide line level audio program distribution into system.
    b. Program Line Input Module shall have a 3.5mm cable jack.
    c. Program Line Input Module shall be configured via web-based user interface.

d. User can configure program distribution to be activated manually or automatically through an event/bell schedule.
e. Program Line Input Module will have a system priority level such that emergency communications override program distribution.

6. IP Addressable Microphone Input Module

a. The system shall support a minimum of five (5) Microphone Input Modules per school.
b. Microphone Input Module shall support dynamic and condenser style microphones.
c. Microphone Input Module shall support microphones with or without Push-To-Talk functionality.
d. Microphone Input Module shall support configurable paging priorities.
e. Microphone Input Module shall provide user feedback for paging activity.
f. Microphone Input Module shall have adjustable microphone gain levels.
g. Microphone Input Module shall be configurable from the web-based user interface.
h. Live pages from the Microphone Input Module can automatically increase audio priority during an emergency.

D. IP Addressable Analog Gateway

1. IP Addressable Gateway provides integration with existing analog wiring infrastructure – consisting of shielded two-pair classroom field wiring. The Gateway provides the ability to reuse speaker wiring, speakers, and punch blocks to integrate analog infrastructure with IP platform.
2. Each Gateway will have 5 watts of power per port and 25 watts total per device.
3. Supports 24 classrooms that utilize 25 Volt speakers and all current Telecenter call switches for front office notification.
4. Supports minimum of 5 call switch priorities per classroom, capable of lockdown check-in functionality, while reusing existing shielded two-pair classroom field wiring.
5. Classroom intercom volume adjustable from Software interface.
6. Classroom paging volume adjustable from Software interface.
7. Configured to the school network and can be used in conjunction with IP Addressable Modules.

E. IP Addressable Administrative Console – Main Reception

1. A full color screen with 64 soft keys, 3 line select, volume control, push to talk, speakerphone mode and left/right and up/down scrolling.
2. Audio paging access from any Console to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire school.
3. Programmable soft key access from any console on the system to initiate alarm signals within the school to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative console shall have priority over all regular system functions.
4. Programmable soft key access from any console to automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
5. Ability to perform intercom to any single IP Addressable Speaker Module.
6. Ability to display 3 call-ins at a time on the screen while other call-ins are annunciating and the ability to scroll to view all call-ins.
7. Ability to upgrade a call-in via soft key.
8. Programmable soft key access from any console for activating relays, campus wide.
9. Ability to maintain, along with controller and other IP Modules system functions, including intercom, bells and paging for the local campus in the event of district-wide connection loss.
10. Classrooms that have not ‘checked-in’ during an emergency are listed on the Administrative Console’s screen.
11. The time duration of an emergency is shown on the screen of the administrative console. The check-in timer is shown on the screen of the administrative console.

F. Audio Paging/Program Amplifiers

1. Power amplifier(s) shall be provided to provide a minimum of 2 watts of power to all paging speakers, and 15 watts of power to all paging horns.
2. The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.

G. Normal/Emergency Call Switch – Rauland Dual Level Call In Switch

1. Normal/Emergency Call Switches indicated on the drawings shall provide the following functions and features:
    a. One (1) “Normal” call switch that shall activate a distinctive “NORMAL” level call from single button activation. The button shall be clearly marked “NORMAL” and will route the call-in to any one or more Administrative Consoles and/or Marquee Displays for quick and easy response from an Administrative Console.
    b. One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY” and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles.

H. Emergency/Check-In Call Switch – Rauland Check-In Call In Switch – Locations as Shown on Drawings

1. Emergency/Check-In Call Switched indicated on the drawings shall provide the following functions and features:
    a. One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY” and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles.
    b. One (1) “CHECK-IN” call switch that shall activate a distinctive “CHECK-IN” level call from single button activation. The button shall be blue in color and shall be clearly marked “CHECK-IN” and will route the call-in to any one or more Administrative Consoles. This button will be used for emergency check-ins during school emergencies, notifying the front office of the classroom occupants’ safety during an emergency.

I. Status Light - Locations as Shown on Drawings

1. Status Light will be powered and controlled by an IP Classroom Module.
2. Status lights will 2 light segments, one for classroom status and one for school status.
3. Each segment will display specific colors and blink patterns based on status priorities.
4. If you add a visual message board an additional status light can be added and driven on the 1 cat wire delivered to the classroom. Both lights can be used for different notifications inside and outside the room.

J. Zone Page Amplifier Module

1. Depending on configuration the amp output is either 14 or 35 watts output.
2. Can be wall or rack mounted.
3. Powered with either a wall wort or POE+

K. Visual message boards. - Locations as Shown on Drawings

1. Can be powered by either POE or POE+ depending on size and features.
2. Comes in 2 sizes

3. Large 2 lines 16 by 80 LED display
4. Small 1 line 8 by 40 LED
5. 3 color LEDs: Red, Amber and Green

L. Equipment Racks

1. All equipment racks shall provide 44 spaces (77") minimum for mounted system equipment.
2. All equipment racks shall be multi-rack format ("gangable") style, bolted together, and open cavity.
3. All equipment racks will be provided with lockable rear doors.
4. Equipment rack(s) shall be in climate-controlled areas/rooms as shown on drawings.
5. All head-end, distribution, and source equipment, including data and power, shall be in racks configured as approved by the Engineer.
6. Rack mounted equipment shall be accessible from front and rear.
7. All unused rack spaces will be covered with appropriate blank/vent panels.

M. Wireless Clock System

1. Provide complete and satisfactorily operating NTP Synchronized Wireless Clock System with analog and/or digital secondary clocks as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated.
2. (NTP) Network Time Protocol is a network standard protocol that assures accurate synchronization to the millisecond of computer clock times in a network of computers. Based on UTC, NTP synchronizes client workstation clocks to the U.S. Naval Observatory Master Clocks in Washington, DC and Colorado Springs, CO. Running as a continuous background client program on a computer, NTP sends periodic time requests to servers, obtaining server time stamps and using them to adjust computer clocks.
3. The system shall be easy to learn and operate. All standard system programming shall be user friendly to allow the system administrator the ability to easily program system features.
4. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information.
5. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.
6. The NTP Synchronized Wireless System consists of a master transmitter located on the inside of the building, and an NTP receiver connected to a time server. Wireless analog and digital clocks are synchronized to the NTP time. System shall synchronize all clocks to each other. System shall utilize NTP technology to provide atomic time to components.
7. System shall not require hard wiring for its components except for AC Power. Analog Clocks may be battery operated for full portability if required.
8. Analog Clocks shall synchronize to +/- 1 second of the transmitter displayed time.
9. Clocks shall automatically adjust for Daylight Saving per settings on the transmitter
10. The system shall have an internal clock that is continually updated by the NTP receiver. If an NTP failure were to occur, the clocks would continue to be synchronized to the internal clock and would not deviate from each other. Once NTP time is restored, all clocks would once again be synchronized to the NTP time.
11. The system must have a failsafe design so that if a power interruption were to occur, the clocks will continue to operate. If a sync signal is not received by the analog clocks for 48 hours, the second hand will double pulse to indicate this condition. Upon restoration of power, the transmitter will once again communicate with the clocks and normal operation will resume.
12. Battery Powered Analog Clocks shall require 2 "D" cell batteries.
13. System shall be 100% programmable from the front operational panel with lights that indicate power status and NTP reception. Panel programming will also include Time Zone, Frequency, 12- or 24-hour operation and DST on/off.
14. The wireless backbone must support expansion of the system to include wireless alphanumeric displays for emergency crisis communications for district-wide communications.
15. The system may be modified to use GPS instead of NTP as the time source without the need to replace the transmitter. A GPS receiver would need to be added with access to the outside of the building.

16. The system shall lend itself to expansion by simple addition of wireless secondary clocks and their required power source.

N. Wall Mounted Horns (Paging Speaker Type 1)

1. Provide double re-entrant type horn loudspeakers with integral driver. The horn loudspeaker shall be impervious to weather and vandalism. Horn shall be constructed of heavy-duty ABS plastic. Horn loudspeaker drivers shall be rated at 15 watts with a frequency response of 480 Hz to 14 KHz. Sensitivity shall be 106 dB 1 watt, 1 meter. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. Dispersion pattern shall be 180 degrees conical. The horn loudspeaker shall be constructed of treated heavy gauge aluminum, with all exposed parts potted and a sealed driver. Wiring terminal shall be fully enclosed. The speaker flange and mounting surface shall have a cork-rubber gasket. The horn loudspeakers finish shall be gray baked on enamel.
2. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4”x10-3/4”x6” deep.
3. The baffle shall be vandal proof, the faceplate constructed of 14-gauge carbon steel with a minimum tensile strength of 55,000 PSI. A lattice grid sub-plate shall deny access to the horn but be acoustically transparent for sound projection. Provide tamper proof, stainless steel mounting hardware. The baffle shall a mar/scratch baked epoxy rust inhibitive finish.

O. Interior Ceiling Speakers (Paging Speaker Type 2)

1. Provide Ceiling Speaker Assembly consisting of 8 Ohm, 8” speaker mounted in a 2 foot by 2 foot, or 2 foot by 1 foot, lay-in baffle, with an integrated back box that covers the full area of the baffle.
2. The speaker shall be connected by inserting an 8-pin RJ45 terminated CAT 5e or Cat 6 cable.
3. The speaker shall include provisions to allow attachment of a safety cable if required.

P. Uninterruptible Power Supplies (UPS)

1. UPS equipment provided for this system will include Power Conditioning to smooth current and voltage fluctuations.
2. UPS equipment will be sized in accordance with the system manufacturer’s recommendations.
3. Provide an individual UPS for EACH SYSTEM CONTROLLER (Gateway) furnished with the system.
4. Provide additional UPS(s) for protection of all other equipment furnished with the system and housed in the equipment racks.
5. All UPS equipment shall be rack mounted.

Q. EQUIPMENT AND MATERIALS

a. WIRELESS TRANSMITTER

1) FCC Part 90 Approved, 467.2125-467.4375 MHz frequency range
2) Radio Technology (Narrowband FM, 12.5 KHz bandwidth)
3) 10 selectively available channels
4) 5-watt transmitter
5) Daylight Savings Time pre-programmed
6) Time Zone Pre-set
7) Non-Volatile Memory
8) LCD Display for time, date, year, power, time zone and signal reception
9) Operating Range (32 degrees F to 158 degrees F)
10) Rack or Shelf Mount
11) Power Supply Input: 120-volt AC, Output: 12-volt DC, 3 Amps
12) 7” Rear Mounted Antenna
13) Dimensions: 12” L x 6” W x 1.75”H Weight: 2 lbs.

14) NTP or GPS Receiver
15) Optional External Antenna for use in large campus applications.

b. SECONDARY 2.5” DIGITAL CLOCK

1) 2.5” Digital Clock (AC Powered 24V or 120V)
2) 4 Digit (Hours/Minutes)
3) Built-in Countdown/Count-up Timer
4) Maintenance Free
5) Five-year manufacturer’s warranty
6) Microprocessor based with built-in wireless receiver
7) Heavy Duty Construction
8) 12/24 Hour Display Format
9) Clear Anti-Glare LED Display
10) Adjustable Brightness
11) AM/PM Indicator
12) Wire Guard in areas where protection is required as indicated on drawings or by owner
13) Bright Red LED Digit

c. SECONDARY 4” DIGITAL CLOCK

1) 4” Digital Clock (AC Powered 24V or 120V)
2) 4 Digit (Hours/Minutes)
3) Built-in Countdown/Count-up Timer
4) Maintenance Free
5) Five-year manufacturer’s warranty
6) Microprocessor based with built-in wireless receiver
7) Heavy Duty Construction
8) 12/24 Hour Display Format
9) Clear Anti-Glare LED Display
10) Adjustable Brightness
11) AM/PM Indicator
12) Wire Guard Model in areas where protection is required as indicated on drawings or by owner.
13) Bright Red LED Digit

d. SECONDARY 2.5” DUAL SIDED DIGITAL CLOCK

1) 2.5” Digital Clock (AC Powered 24V or 120V)
2) 4 Digit (Hours/Minutes)
3) Built-in Countdown/Count-up Timer
4) Maintenance Free
5) Five-year manufacturer’s warranty
6) Microprocessor based with built-in wireless receiver
7) Heavy Duty Construction
8) 12/24 Hour Display Format
9) Clear Anti-Glare LED Display
10) Adjustable Brightness
11) AM/PM Indicator
12) Bright Red LED Digit

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. Coordinate all requirements for WAN/LAN IP network cabling with the network cabling installer, including location, quantity, and type.

C. Furnish and install all material, devices, components and equipment for a complete operational system.

D. Impedance and Level Matching: Carefully match input and output impedance’s and signal levels at signal interfaces. Provide matching networks where required.

E. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.

F. All housings are to be located as indicated.

G. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

H. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

I. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.

J. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

K. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.3 GROUNDING

A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. 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 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

C. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

C. Testing: Rectify deficiencies indicated by tests and completely re-test 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.

3.5 FINAL ACCEPTANCE TESTING

A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.

B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner’s Representative establishing the “In Warranty” date. The warranty period will not commence until the Final Acceptance Test is completed.

C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.6 COMMISSIONING

A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training.

B. Schedule training with Owner through the owner’s representative, with at least seven days advance notice.

3.7 OCCUPANCY ADJUSTMENTS

A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

3.8 CLEANING AND PROTECTION

A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION

SECTIOIN 28 10 10

ACCESS CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. 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 - Boxes for Electrical Systems
6. 27 10 10 – Voice and Data Cabling Distribution System
7. 27 05 00 – Common Work Results for Communications
8. 28 13 53 – IP Video Intercom Systems
9. 28 16 00 – Building Security and Intrusion Detection System
10. 28 23 00 – Video Surveillance System

1.2 SCOPE OF WORK

A. Card Access System:

1. Installation of the Card Access system components including all required wiring to fully interface Access Control software database operated at the districts head end, including the existing access control database server software.
2. The system will provide full access control of door locations indicated. The system will provide proprietary software and password protection to prevent unauthorized modification or use of this system.
3. The systems shall be installed at location as shown on the plans. The installer will provide all system programming for the system and designated components.
4. The system shall be complete with all wiring, equipment enclosures, conduit and power supplies required for a fully operational system including door locking hardware (strike or magnetic). All wiring will conform to methods and materials described in these specifications and comply with all applicable NEC, state and local codes.
5. Include integration with the Door Lock-Down System, including required Lock-Down Buttons, and other EMS ISD systems.
6. Include integration of the Access Control systems for authorized access and operation of the following:
    a. Video intercom system
    b. Video surveillance system
    c. Intrusion detection and alarm system.
7. Contractor must coordinate all door hardware requirements with door hardware schedule and must review door hardware submittals.

1.3 QUALITY ASSURANCE

A. Manufacturer:

1. Minimum of 10 years experienced in providing security access control components for projects of similar nature and complexity.
2. Maintain a 24-hour toll free telephone assistance line for installing dealer support.
3. Installer:
   a. Minimum of 5 years experience in performing work of this section who has specialized in the installation of work similar to that required for this project.
   b. Have at least one technician trained by the manufacturer.
   c. Maintain adequate supply of replacement parts for system components provided.

B. Regulatory Requirements: Installed products shall meet standards of a recognized testing laboratory (UL. or comparable).

1.4 SUBMITTALS

A. Submit in accordance with requirements of Section 01 33 00.

B. Shop Drawings: Detailing all connected devices, of sufficient detail to adequately communicate that recommended software meets access system requirements, including:

1. System device locations on architectural floor plans.
2. Full schematic wiring information for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at devices.
3. A complete access control system one-line block diagram.
4. System sequence operation description.

C. Product Data:

1. Manufacturer’s data for all material and equipment, including terminal devices, local processors, computer equipment, access cards, and any other equipment required for the complete access management and alarm monitoring system.
2. System description, including analysis and calculations used in sizing equipment, and also indicating how equipment will operate as a system to meet the performance requirements of the access control and alarm monitoring system.
3. A description of the operating system and application software.

D. Contract Close-out Submittals:

1. Operating instructions.
2. Recommended maintenance required and maintenance intervals.
3. Parts list, including: wiring and connection diagrams.
4. Record Documents: Maintained on a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the access control and alarm monitoring system, accurately reflecting all changes and additions to the access control and alarm monitoring system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 01 60 00.

1. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
2. Store materials protected from exposure to harmful environmental conditions and at temperature conditions recommended by manufacturer.
3. Handle products and systems in accordance with manufacturer's instructions.

1.6 WARRANTY

A. Project Warranty: Comply with requirements of Section 01 78 36.

B. Manufacturer's Warranty: Submit manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Type: Complete closed circuit, electrically supervised, microprocessor-controlled systems.

B. The systems and all components shall be tested and found suitable for the specified purpose as part of a commercial security system by a nationally recognized approval agency acceptable to the AHJ.

C. All date keeping hardware, firmware, and software provided shall be fully compliant with current date and dates beyond. Any time equations must function normally; leap year, and daylight savings time must be supported.

D. The control units, power supplies, batteries, subassemblies, software, firmware, and all cable, detection, and notification devices provided shall be listed and labeled by Underwriters Laboratories, Inc. for commercial security system use under the latest appropriate testing standard but not limited to the following:

1. UL 13 Power Limited Circuit Cables
2. UL 50 Enclosures for Electrical Equipment
3. UL 294Access Control System Units
4. UL 444 Communications Cables
5. UL 1481 Power Supplies for Fire Protective Signaling Systems
6. UL 1581 Electrical Wires, Cables, and Flexible Cords
7. UL 1610 Central-Station Burglar Alarm Units
8. UL 1635 Digital Alarm Communicator System Units

E. Only equipment devices have been shown on the contract drawings. Specific wiring between equipment has not been shown.

F. The system shall include but not be limited to all control units, power supplies, batteries, subassemblies, door controllers, readers, keypads, software, firmware, and all cable, detection, notification, and all accessories required to provide a complete operating system.

G. All equipment and components shall be installed in strict compliance with manufacturer’s recommendations and the requirements of the component’s UL listing. Consult the manufacturer’s installation manuals for all wiring diagrams, schematics, electrical requirements, cable types, and physical equipment sizes, etc., before beginning system installation. Refer to the manufacturer’s riser/connection diagrams for all specific system installation/termination/wiring data.

H. All equipment and components shall be new, and the manufacturer’s current model. All like devices shall be of the same manufacturer and model number.

I. 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.

J. Installation subject to approval, inspection, and test by the Architect/Engineer

2.2 MANUFACTURERS

A. Approved Manufacturers:

1. Hirsch – Velocity Enterprise

B. Requests for substitutions will be considered in accordance with provisions of Division 1. In the absence of direction by Division 1, substitution request must be submitted no less than ten (1) business days from the time of proposal.

2.3 SERVERS AND USER INTERFACE

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. Contractor / VAR shall provide end-user training to end-user satisfaction.

2.4 ACCESS CONTROL PANEL HARDWARE

A. 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. The door or doors leading from the reception area into the administrative area (and any other doors designated by the Owner) shall be on separate ACPs from all other access control doors. The intent is to omit these doors/ACPs from the lock down high priority security level generated by the activation of a duress button.
3. Acceptable product:
   a. Hirsch MX-8 Door Controller
   b. Hirsch MX-2-N3 Door Controller
   c. Approved equivalent.
4. Power Supply(s) and Batteries: power supply and sealed back-up batteries shall be included with the ACP.

5. 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 the quarter of one inch from its closed position. This alarm shall be sent to the Monitoring Station.
6. I/O boards as required.
    a. Hirsch AEB8
    b. Approved equivalent.
7. Other equipment required to provide a functional, working system.

B. 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 the Altronix AL600ULACM 8-Door Power Supply to be installed in the communication rooms with the access control panels.

C. 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 rectraction

1. Von Duprin 98/99 with QEL option

B. Von Duprin EPT – power transfer device at each door to have access control.

C. Power supplies shall be connected to the Owner’s network, allowing for remote management, including but not limited to the following:

a. Allow the user to connect any network connected power within a local network or via the internet from any remote location.
b. Allow for all connected power supplies to be monitored for status and firmware revision on a single screen.
c. Allow batch firmware updates to maintain the latest feature sets and cybersecurity standards.

2.6 WIRING

A. All wiring shall be a minimum 18 AWG, and shall be plenum rated. Wiring Shall be sized for full potential loads, with less than 2% voltage drop.

B. Ethernet cabling shall be provided by the Structured Cabling System Installer. In the event that there is not ACS installer on the project, cabling shall be provided and installed by the Access Control System Integrator and shall comply with the Division 27 Structured Cabling specification.

C. Conventional access control cable shall be a jacketed composite cable. The minimum conductor requirement shall be as follows:

1. Standard

a. Lock Power: 4-conductor, 18AWG, shielded
b. Card Reader: 6-conductor, 22AWG, OA shielded
c. Door Contact: 2-conductor, 22AWG, shielded
d. Request to Exit/Spare: 4-conductor, 22AWG, shielded

2. Extended Distance

a. Lock Power: 4-conductor, 16AWG, shielded
b. Card Reader: 6-conductor, 18AWG, OA shielded
c. Door Contact: 2-conductor, 18AWG, shielded
d. Request to Exit/Spare: 4-conductor, 18AWG, shielded

D. Wire scheme and conductor quantity shall be as required by the manufacture's specifications. Contractor to provide and install shielded cable as required.

E. All 120v Power shall be furnished by the Division 26 contractor. In the event that a division 26 contractor is not contracted for the project, the system installing contractor shall contract a licensed.

F. Electrical firm to provide and install all materials required to furnish a complete and operational system.

G. All Security Conduit as required for a complete installation of this system shall be furnished by the division 26 contractor as part of their scope of work. In the event that a division 26 contractor is not contracted for the project, the system installing contractor shall provide and install all conduit required.

H. Coordination with the Division 26 contractor is the responsibility of the Security Contractor to ensure all conduit is in place for a complete installation.

I. All systems shall be connected to a dedicated circuit and on an emergency power source if available

2.7 FIELD HARDWARE POWER SUPPLIES

A. Power Supplies for field hardware shall be compatible with the Access Control equipment installed. Power supplies shall be regulated, linear, and isolated versions for the field controllers and other equipment. Each version shall be available in UPS with battery backup and non-UPS models. All power supplies shall be housed in tampered, locked enclosures, Altronix ACM Series.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install system components and appliances in accordance with the printed instructions.

B. Provide all necessary interconnections, services, and adjustments required for a complete and operable system.

C. Install control signal, communications, and data transmission line grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3.2 FIELD QUALITY CONTROL

A. Testing:

1. Supply a proposed acceptance test procedure.
2. Testing of system shall be the sole responsibility of the Contractor.
3. Communications tests:
    a. Controllers to manager server.
    b. Manager server to client.
    c. Remote dial-up support.

B. Inspection:

1. Provide an on-sight, factory-trained technician to assist, advise or manage installing personnel.
2. All final connections shall be made under the direct supervision of the Systems Integrator.

C. Field Service:

1. Provide first line support for both the hardware and software properties of the selected system.
2. Provided second line support directly from the manufacturer for all component and computer hardware and all operating and application software that comprise the complete system.
3. Determine and report all problems to the manufacturer’s customer service departments.
4. Support shall be available to the integrator via the following methods:
    a. Phone inquiries.
    b. Direct dial-in to the customer system for remote system troubleshooting by a qualified Field Service Engineer.
    c. On-site visits if required, upon approval by the manufacturer's Customer Service Manager.

3.3 ON SITE COMMISSIONING AND TRAINING

A. The installing company shall provide direct participation in the on-site commissioning activity of new systems. Not less than 16 hours of on-site training shall be provided for a maximum of 6 representatives of Owner.

B. Provide systems administrator that is factory trained with the expertise on installing, configuring and commissioning the system to the customer’s specific requirements; and to provide on-site training on system operation and administration.

C. On-site shall be available for system administrators, Operators and other qualified personnel.

D. On site commissioning shall include:

1. Hardware set-up and testing.
2. Preventative maintenance and troubleshooting training.
3. End User training.
4. Database configuration and build assistance.

3.4 FINAL ACCEPTANCE

A. Perform the following performance standards before final acceptance:

1. Operate all mechanical devices without down time for a period of 10 days.
2. Operate all electronic devices and equipment without downtime or programming problems for a period of 30 days.
3. Upon completion of system testing and before the acceptance cycle, provide 2 copies of system manual to Owner.

END OF SECTION

SECTION 28 13 53

IP VIDEO INTERCOM SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. IP Video Intercom. (Aiphone IX Series)

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 - Boxes for Electrical Systems
6. 27 10 10 – Voice and Data Cabling Distribution System
7. 27 05 00 – Common Work Results for Communications
8. 28 10 10 – Access Control System
9. 28 16 00 – Building Security and Intrusion Detection System
10. 28 23 00 – Video Surveillance System

1.2 REFERENCES

A. American National Standards Institute (ANSI/TIA/EIA) 568 - Commercial Building Telecommunications Cabling Standard.

B. International Organization for Standards (ISO) 9001:2000 - Quality Management Systems - Requirements.

1.3 SYSTEM DESCRIPTION

A. IP Network Compatible Video Intercom System: A network-based communication and security system featuring video entry security, internal communication, emergency stations, and paging. All units and app in the systems shall be able to unlock doors remotely on a network, assist onsite visitors from an offsite location, broadcast emergency announcements, and communicate using a PoE network.

1. Power Source: Power over Ethernet (802.3af).
2. Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).
3. Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.
4. Bandwidth Usage:
   a. G.711: 64Kbps x 2 per video call.
   b. 64Kbps per monitor.
   c. H.264: 24Kbps ~ 2,048Kbps.
5. Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).
6. Video Display: 3-1/2 inches (89 mm) color LCD.
7. Camera: Type:
   a. 1/4 inch (6 mm) color CMOS.
   b. View Area: 2 feet 2 inches (660 mm) vertical x 3 feet 1 inch (940 mm) horizontal at 20 inches (508 mm).
8. Video Stream: ONVIF Profile S.
9. Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA (use RY-24L for larger contact rating, which requires 24V DC power supply) or use RY-IP44 with 4 multipurpose relays.

10. Wire Type: CAT-5e or CAT-6.
11. Distance:
    a. Any station to Network Node: 330 feet (100 meters).

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Shop Drawings: Submit the following:

1. Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
2. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

D. Installation and Operation Manuals:

1. Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
2. Provide detailed information required for Owner to properly operate equipment.

E. Warranty: Submit manufacturer's standard warranty.

F. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

G. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001:2008 certified company.

B. Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship is approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.

C. Handling: Protect materials during handling and installation to prevent damage.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Aiphone Corp., which is located at: 6670 185th Ave. NE; Redmond, WA 98052 ; Toll Free Tel: 800-692-0200; Tel: 425-455-0510; Fax: 425-455-0071; Email:request info (marketing@aiphone.com); Web:www.aiphone.com

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

D. IP Video Intercom System: IX Series Intercom System as manufactured by Aiphone Corporation.

2.2 FUNCTIONAL COMPONENTS:

A. Functional Components: As indicated on the drawings or as required to complete system.

1. Video Master Station Model IX-MV7-HB-L:

a. An IP addressable video master station with a 7” color LCD tochscreen. It can be wall or desk mounted (desk stand included). The IX-MV offers handset (duplex) and hands-free (VOX/PTT) communication and call up to 500 other IX stations. SIP 2.0 compliant, ONVIF Profile S compliant. It connects directly to a network using CAT-5e/6 cable. This station requires a 802.3af compliant Power-over-Ethernet network.

2. Audio/Video Door Station Model IX-DVF:

a. Surface mount station connects to a PoE network using CAT-5e/6 cable. The IX- DVF will call up to 20 IX-MV masters or Instances of the IX MOBILE. The door station features a form C contact for door release, a 600 ohm output for paging or an amplified speaker, call placed/answered indication, and a contact input. Provide with stainless steel surface mount enclosure, SBX-IDVF.

3. RY-IP44 IP Programmable Relay Adaptor:

a. 4 contact inputs and 4 relay outputs (compatible with the IX Series, IS-IP Series, and IPW-1A only).

4. 2-Wire Network Adapter Model IX-1AS:

a. One 2-wire input with 2 built-in contact outputs; door release and camera call-up. Powered via PoE, Compatible with Aiphone's LE and NE series audio door or substations for connection to Video Master Station Model IX-MV7-HB-L over a network.

5. Wire Network Adapter Model IX-10AS (Ten IX-1AS adaptors in a rack mounted enclosure):

a. Ten 2-wire inputs with ten, 2 built-in contact outputs; door release and camera call-up. Powered via PoE, Compatible with Aiphone's LE and NE series audio door or substations for connection to Video Master Station Model IX- MV7-HB-L over a network.

6. Network Paging Adapter Model IX-PA:

a. Address book that supports up to 50 stations and can be connected to 3rd party devices. Can be accessed by an IX-MV master station or an instance of the IX Mobile App to allow messages to be broadcast through the IX-PA 600u or 8u output. A 3rd party device can be connected to the audio input to send messages to the paging adaptor's address book.

7. Stainless Steel Enclosure Model SBX-IDVF:

a. 18-Guage stainless steel enclosure designed for surface mounting the IX-DF, IX- SS, IX-DF-HID, and IX-DF-RP10 door stations.

8. Stainless Steel Enclosure Model SBX-ISDVFRA:

a. 18-Guage stainless steel enclosure designed for surface mounting the IX rescue assistance sub stations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive integrated security and communication system.

B. Notify Architect of conditions that would adversely affect installation or subsequent use.

C. Do not begin installation until unacceptable conditions are corrected.

D. PREPARATION

E. Verify the following compliance before starting installation.

1. The unit turns inoperative during power failure.
2. Keep the intercom wires at least 1 foot (30 cm) away from strong electrical wiring (AC 100-240 V) including, in particular, wiring for inverter electrical appliances. Noise and malfunction could result.
3. If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
4. Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
5. The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

3.2 INSTALLATION

A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.

B. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.3 SET-UP AND ADJUSTING

A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.4 DEMONSTRATION AND TRAINING

A. Demonstration:

1. Demonstrate that integrated security and communication system functions properly.
2. Perform demonstration at final system inspection by qualified representative of manufacturer.

B. Instruction and Training:

1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
3. Provide instruction and training by qualified representative of manufacturer.

3.5 PROTECTION

A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION

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SECTION 28 16 00

BUILDING SECURITY AND INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. 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 - Boxes for Electrical Systems
6. 27 10 10 – Voice and Data Cabling Distribution System
7. 27 05 00 – Common Work Results for Communications
8. 28 13 53 – IP Video Intercom Systems
9. 28 10 10 – Access Control Systems
10. 28 23 00 – Video Surveillance System

1.2 SUMMARY

A. Scope of Work:

1. Provide a complete and operational alarm system.

B. Security system devices indicated are for reference and coordination purposes only. The installing contractor shall design and provide a complete system. The Contractor shall provide all security system devices required for complete system perimeter coverage acceptable to all governing authorities.

C. The system shall include security for all access into building, including but not limited to doors, roof hatches, windows and interior space motion detection.

1. The Control System shall be the product of a single manufacturer.
2. Tag all conductors or cables at each end.
3. Installation of security panels.
4. Interconnection of security panels.
5. Installation of new security devices.
6. Full coverage of all windows and doors (as required by owner).
7. Preconstruction meeting with Owner’s personnel, installing technician and project superintendent.

D. The system shall be wired as a Class A system for all circuits.

E. These specifications include all of the security equipment and will be awarded to the specific PISD bid contractor. This may include whole, partial or part of the contract in any area of the equipment needed and be in the best interest of PISD.

1.3 CODES AND STANDARDS

A. The system shall comply with the applicable Codes and Standards as follows:

1. National Fire Protection Association Standards:
2. NFPA 70 National Electric Code
3. NFPA 72 National Fire Alarm Code
4. NFPA 101 Life Safety Code

B. Local & State Building Codes.

C. Requirements of Local Authorities having Jurisdiction.

D. Underwriter's Laboratory Requirements and Listings for use in Security Alarm Systems.

E. Requirements of American Disabilities Act (Public law 101-336).

F. Texas Accessibility Standards (T.A.S.).

G. State Fire Marshall.

H. Texas Insurance Code.

1.4 QUALITY ASSURANCE

A. Contractor Qualifications:

1. The installing contractor shall be the authorized representative of the Security Manufacturer to ell, install, and service the proposed manufacturer's equipment. The installing contractor shall have represented the security manufacturer's product for at least two years.
2. The installing contractor shall be licensed by the State of Texas as a security services contractor to design, sell, install, and service security alarm system.
3. The installing contractor shall provide 24 hour, 365 day per year emergency service with factory trained service technicians.
4. The installing contractor shall have been actively engaged in the business of designing, selling installing, and servicing security systems for at least five (5) years.

1.5 SUBMITTALS

A. The installing contractor and/or equipment supplier shall provide complete and detailed shop drawings and include:

1. Control panel wiring and interconnection schematics.
2. Complete point to point wiring diagrams.
3. Riser diagrams.
4. Complete floor plan drawings locating all system devices.
5. Factory data sheets on each piece of equipment proposed.
6. Detailed system operational description. Any specification differences and deviations shall be clearly noted and marked.
7. Complete system bill of material.
8. Line by line specification review stating compliance or deviation.

B. All submittal data will be in bound form with Contractor's name, supplier's name, project name, and state security license number adequately identified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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. Alarm Controls RP-44
    b. Approved equivalent

E. All references to manufacturer’s model numbers and other pertinent information herein are intended to establish minimum standards of performance, function, and quality. With approval, equivalent, compatible, U.L. listed equipment from other manufacturers may be substituted for the specified equipment, as long as all requirements are met. Substitutions require prior written approval of the Owner.

F. The model numbers used constitute the quality, features, and performance of the equipment to be furnished. The following are acceptable manufacturers, (any other proposed suppliers must be pre-approved).

G. Keypad

1. Two-line, alphanumeric keypad, Bosch model B920.
2.

H. Surge and Amperage Protection

1. Electrical surge protection shall be provided for all service entrance connections and on each copper pair that connects on building to another (i.e. any other portion of a building complex not under one continuous roof) at both exit points to prevent damage to equipment.
2. Security system circuit surge protectors shall be mounted in a standard grounded metallic electric box. Shall be Ditek, 12345-A Starky Road, Largo, Florida 35643 model numbers as follow, multiple pair units are available, or equivalent:
    a. Part No. DTK-1LVLP-X 2 wire protector for 12 Volt circuits.
    b. Part No. DTK-1LVLP-D 2 wire protector for 5 Volt circuits.

I. Cabling

1. All cabling is to be concealed where construction permits.
2. This contractor shall provide and install new and unused ASTM bare stranded copper conductor wire per ANSI/NEMA codes. Follow the manufacturer’s instructions. All wire shall be recommended by the manufacturer for security system applications.
3. All wiring for sensor circuits shall be West Penn Wire No. 221, 22 AWG stranded, NEC type CMR, two conductor cable. Provide Plenum rated equivalent where required by code.

4. All wiring for signal circuits shall be West Penn Wire No. 226, 14 AWG stranded, NEC type CMR, two conductor cable. Provide Plenum rated equivalent where required by code.
5. All wiring for power/alarm circuits shall be West Penn Wire No. 244, 18 AWG stranded, NEC type CMR, two conductor cable. Provide Plenum rated equivalent where required by code.
6. All wiring for keypad circuits shall be West Penn Wire No. 440, 18 AWG stranded, NEC type CMR, two individually shielded pairs, cable. Provide Plenum rated equivalent where required by code.
7. Equivalent products by Beldon or Carol.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each motion detector shall feature a home run cable wired to an individual system zone or a network loop with popit connections.

B. Each cable run shall be free of splices and labeled on each end.

C. System cabling and equipment installation shall be in accordance with good engineering practices as established by the NEC and EIA. Cable installation shall meet all state and local electrical codes.

D. Before energizing the system check all cables for correct connections and test for short circuits, ground faults, continuity, and insulation.

E. Install sensors ceiling or wall as noted on drawings or a required by location(s).

F. Each cable run shall include a three foot service loop with wire tie located in the ceiling above the rack. This is to allow for future re-termination or repair.

G. Mount all equipment firmly in place. Route cable in a professional, neat and orderly installation.

H. All cabling will be placed with regard to the environment, EMI/RFI interference and its effect on communication signal transmission.

I. Do not route any communication cable within two feet of any light fixture, HVAC unit, service access area, electric panel, or any device containing a motor or transformer.

J. Communication cable will not be installed in the same conduit, duct or track with line voltage electrical cable.

K. Maximum pulling tension should not exceed 25 lb. /ft. or manufactures recommendation, whichever is less.

L. No terminations, splices or equipment will be installed in or above ceilings.

M. Cable bends shall not exceed the manufacturer’s suggested bend radius.

N. Communication cables shall be run in conduits where provided from junction boxes to above accessible ceilings.

O. Install security wiring in conduit where wiring will not be accessible.

P. Communication cables shall be run in bundles above accessible ceilings and supported from building structure.

Q. All conduit, ducts, track and raceways shall be supported from the structure at industry standard intervals for the size specified, utilizing proper anchoring devices and techniques for each type of cable used.

R. Communication cables shall not be run loose on ceiling grid or ceiling tiles.

S. Conduit, duct or track will be used for communication cable in exposed areas.

T. All cables shall be installed such that the cable is not crimped, crushed or deformed.

U. Cable ties shall not be tight enough to deform cable and induce crosstalk.

V. Provide for adequate ventilation in all equipment and take precautions to prevent electromagnetic or electrostatic hum.

W. Termination practices:

1. Strip back only as much cable jacket as required to terminate.
2. Preserve wire twists as closely as possible to point of termination (0.5” maximum) to keep signal impairment to a minimum.
3. Avoid twisting cable during installation.

3.2 TESTING, WARRANTY, SERVICE

A. A factory trained representative of the manufacturer shall supervise the final connections and testing of the system and it shall be subject to the final acceptance of the Architect/Engineer and Owner.

B. The Security System Contractor shall make a thorough inspection and test of the complete installed security system including all components such as motion detectors, and controls, to ensure the following:

1. Complete and functional system.
2. Installed in accordance with manufacturers instructions.
3. Confirm at the panel, with an ohm meter, that each zone has an end of line resister properly installed.
4. Each of the alarm conditions that the system is required to detect should be introduced on the system including disconnection to the telephone line.
5. A walk test to confirm that each detector is located and properly aimed for the intended coverage area.
6. Verify that all tripped devices display the correct zone identification at the keypads.
7. Verify the proper processing of the signal at the panel and the correct activation of local alarms and the digital communicator.

C. The contractor shall provide a warranty of the installed system against defects in material or workmanship for a period of one (1) year from the date of substantial completion. Any equipment or wiring shown to be defective shall be replaced, repaired, or adjusted free of charge. All labor and materials shall be provided at no expense to the Owner. All equipment will carry a one year warranty or manufacturers warranty whichever is greater.

3.3 DRAWINGS, MANUALS, AND TESTING

A. Upon completion of the installation and prior to final inspection, this Contractor shall furnish two (2) copies of as-built drawings. In addition, this Contractor shall furnish four (4) copies of a manual giving complete instructions for the operation, inspection, testing and maintenance of the system including wiring diagrams. Include copies of all programming sheets used to program the system.

B. Formal on-site training sessions shall be conducted by the security system contractor. It shall be the responsibility of the Contractor to coordinate time and location of training sessions with the Owner. Provide documented general instruction as follows:

1. Provide instruction to the maintenance personal to include the location, inspection, maintenance, testing, and operation of all system components. Provide a minimum of two (2) hours training within two weeks of the substantial completion of the project.

2. Provide instruction to designated personnel on the functions and operation of the security system including zoning, capabilities, limitations, monitoring, and the meaning of status messages. State the proper procedure for testing, routine maintenance, and request for service. Provide detailed instruction on the operation of the keypad including arming, disarming, adding users, deleting users, and changing passwords. Provide a minimum of two (2) hours training within two weeks of the substantial completion of the project.

END OF SECTION

SECTION 28 23 00

VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. Refer to Section 27 00 00 for additional project scope information.

1.2 RELATED WORK

A. References to the following related documents do not limit or release the Contractor from the responsibility of having the necessary knowledge of other non-referenced related documents that makeup the Construction Document Package.

1.3 RELATED SECTIONS

A. 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 - Boxes for Electrical Systems
6. 27 10 10 – Voice and Data Cabling Distribution System
7. 27 05 00 – Common Work Results for Communications
8. 28 13 53 – Access Control Systems
9. 28 16 00 – Building Security and Intrusion Detection System

28 23 00 ─ Video Surveillance System

1.4 GENERAL SUMMARY

A. System shall include IP cameras and a cloud-based NVR at the district server location.

B. The Category 6A cabling to each camera shall be provided by the structured cabling Contractor. Patch cords for the IP cameras to the network switches shall be furnished by this Contractor and installed by the Contractor with participation by this Contractor. Patch cords from the IP Camera to the data jack shall be furnished by this Contractor and installed by this Contractor.

C. System installation shall include, but not be limited to, installation, programming, and configuration of system components as well as all associated software upgrades, patches, and maintenance for the first year.

D. Contractor is responsible for meeting with Owner’s representative at time of camera installation to verify exact placement and view of each camera to ensure coverage area is as intended.

1.5 MOUNTING AND INSTALLATION

A. Contractor shall provide the appropriate mounting hardware for all ceiling types and wall types where cameras shall be located. Plastic anchors of any kind are not acceptable.

B. Wall mounted internal 180 and 360-degree cameras shall be mounted on a gooseneck.

C. All exterior cameras shall be mounted on a gooseneck style mount.

D. Cameras mounted in drop tile shall have a tile support bridge with a steel support cable connected to structure to prevent theft and vandalism.

1.6 CODE AND STANDARD REQUIREMENTS

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association and any other codes as required by the AHJ.

B. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

C. Cameras shall meet the following standards:

1. MPG-4:
    a. ISO/IEC 14496-10:2022, Ultra 265, H.265, H2.64, MJPEG
2. Networking:
    a. IEEE 802.3af (Power over Ethernet)
3. Network Video:
    a. ONVIF Profile S or better

PART 2 - PRODUCTS

2.1 VMS GENERAL REQUIREMENTS

A. VMS proposed must be provided as a turnkey solution. The Contractor must provide all necessary labor, materials, tools, transportation, services, ancillary items, and coordination to furnish the Owner a complete and fully functional turnkey installation as described herein.

B. The VMS shall be a server/client model and be based on a true open architecture that shall allow for use of non-proprietary workstation and server hardware, non- proprietary network infrastructure and non-proprietary storage.

C. The VMS shall include a fully integrated Access Control platform.

D. The server software shall launch automatically when operating system is booted and run in the background regardless if a user is logged on.

E. The VMS shall include Microsoft Active Directory integration. The contractor shall coordinate with the Owner on permissions, roles and integration.

F. The software shall support partitions and limit what users can view in the configuration database. The administrator shall be allowed to segment a system into multiple security partitions. The Contractor shall coordinate with the Owner on required partitions.

1. A user who is given access to a specific partition shall only be able to view component within that partition.
2. A user or user group can be assigned administrator rights over the partition.
3. It shall be possible to specify user and user group privileges on a per partition basis.

G. The VMS server shall be compatible with Microsoft Windows Server Standard 2012 R2 or newer.

H. The VMS shall support video encoded in MPEG-4, MPEG-2, MJPEG, H.264 and Wavelet compression formats.

I. The VMS shall support audio encoded in g711 (u-law), g721, g723 or AAC compression formats.

J. The VMS shall support failover and standby functionality.

K. The VMS system shall integrate with the IP video intercom system camera.

L. The VMS shall synchronize to a common NTP server as the cameras and other security systems.

M. The system shall log all actions on a per user basis, all alarms and notifications on a per device basis and all errors and failures on a per device basis. These logs shall have the ability to be extracted to a document that can be emailed to an administrator.

N. Manufacturer: i-PRO - Video Insight

2.2 VMS CLIENT SOFTWARE

A. Logging into the client software shall be done via Microsoft Active directory and enables features based on user roles and privileges.

B. The look and feel of the interface shall be customizable on a per user basis and enabled on log-in.

C. The software shall include a reporting interface to view historical events based on activity. The user shall be able to perform actions such as generating and printing a report and troubleshooting a specific event from the reporting view. The user shall be able view audit trails that show a history of user and administrator changes.

D. The software shall support graphical maps with multiple hierarchies to facilitate navigation within and between various sites and buildings. The Contractor shall set up these maps to include all cameras and integrated devices like access control, intercom and intrusion detection.

E. The operator shall be able to bookmark multiple cameras and create an incident report with the associated cameras and integrated devices attached. The bookmarks shall be protected from overwriting until the user manually deletes them. The bookmarks shall be able to be moved to a separate storage drive for long term archiving. The user shall be able to pull up a list of all bookmarks saved for easy management of them.

F. The software shall be able to export multiple video clips to a single file system with a self-contained player. These clips shall include the option to be encrypted. The self- contained player shall support multiple and selectable video tiles with the ability to digitally zoom. The user shall be able to build an incident by placing additional video clips into this file system for convenient storage.

G. The software shall support the following additional minimum capabilities: Monitoring the events from a live security system.

1. Monitoring and acknowledging alarms.
2. Creating and editing incidents and generating incident reports. Executing actions from a dynamic graphical map and floor plan. Management and execution of hot actions and macros.
3. Customizable display tiles with drag and drop capabilities.
4. Support a minimum of 6 active displays.
5. Intercom with duplex audio through integrated intercom system or camera equipped with or connected to a microphone and speaker.
6. Control of physical and virtual PTZ cameras with mouse control or PTZ joystick/keyboard control.
7. Client side dewarping of 360 degree enabled cameras with multiple view areas and virtual PTZ control.
8. Display all cameras associated with the system and federated systems.
9. Create snapshots from live or recorded video. These snapshots shall be automatically saved to a snapshot folder.
10. Link cameras in live and recorded views for seamless tracking of a subject throughout a facility. The Contractor shall configure the links for all cameras within and outside of the facility.

H. The Contractor shall provide, install and configure client software up to 5 computers per campus. The Contractor shall coordinate with the Owners to determine viewing privileges. The Contractor shall provide

the Owner with recommended workstation/laptop performance levels early in the project so they may evaluate if hardware updates are required to their existing workstations.

2.3 VMS WEB CLIENT

A. The web client shall not require any download other than a web browser plug-in(s).

B. The Contractor shall provide any mobile web servers and licenses required to support this functionality.

C. The web client shall support the latest versions of the following browsers:

1. Microsoft Internet Explorer
2. Google Chrome
3. Mozilla Firefox
4. Apple Safari

D. The web client shall support Microsoft Active Directory integration.

E. The web client shall support the minimum following functionalities:

1. Live and recorded video playback. Video export.
2. Multiple video tiles. PTZ mouse controls.

2.4 VMS MOBILE CLIENT APP

A. The Contractor shall provide any mobile web servers and licenses required to support this functionality.

B. The mobile client shall support the following operating systems:

1. Apple iOS
2. Google Android

C. The mobile client shall support the following minimum functionalities:

1. Live video monitoring with a minimum of 4 video tiles.
2. Dynamic resolution.
3. Receive mobile push alarm notifications, view and acknowledge alarms.
4. PTZ control with finger. Save snapshots.
5. Video streaming push back to VMS recording server.

D. The contractor shall provide, install and configure mobile client software apps on up to three (3) mobile devices of the owners choosing at each school.

2.5 VMS HEALTH MONITOR

A. The Contractor shall provide, install and configure health monitoring software to be installed on each server running the VMS or a service required for the VMS operation like a SQL server.

B. The Server Monitoring Service shall be a Windows service that automatically launches at system startup, irrespective of whether a user is logged in not.

C. The health monitoring service shall notify the system administrators of any problem or maintenance required.

D. Health events shall be able to create SNMP strings.

2.6 VMS SERVERS

A. General Server Requirements

1. The Contractor shall coordinate with the Owner to install any required antivirus or other software on the servers before it is connected to the network. The Contractor shall also provide the Owner with any required antivirus on-access scanning exclusions for files/folders/processes.
2. The servers shall be rack mountable enterprise grade with Intel Xeon processors, Registered ECC memory, multiple enterprise class Serial Attached SCSI (SAS) hard drives in a RAID configuration, multiple NIC ports and dual power supplies.
3. The servers shall use enterprise class Serial Attached SCSI (SAS) hard drives with a minimum MTBF of 1 million hours and error recovery time limit of approximately 8 seconds or less. Enterprise class SATA hard drives may be used when connected to a SAS backplane.
4. The servers shall be provided with Microsoft Windows Server Standard 2016. The servers shall be provided with Microsoft SQL Server Standard 2016.
5. Microsoft SQL Server Express shall not be used. The contractor shall provide all
6. licenses required for SQL Server Standard. (SQL Server Express is often acceptable, verify the need for full SQL server with manufacturer and client)
7. The servers shall be provided with a 3-year warranty with 8am – 5pm weekday support with next business day replacement and service. (Typical options would include a 5 year warranty, 24/7/365 support and 4 hour parts replacement)
8. The servers shall be purpose built for surveillance, video optimized storage and management. The manufacturer shall guarantee performance with the system design at the time of purchase
9. Workstations or PC Computers shall not be used as a server.

2.7 VMS VIDEO STORAGE

A. Provide a minimum of thirty (30) days of storage calculated at the following resolution and rates. Provide all hardware, software and configuration needed to accomplish this.

B. Provide an additional fifteen (15) days of archived storage calculated at 1 frame per second (I-frame only) with the following resolutions.

C. Record stream using RTP/TCP.

D. Pre and post record buffer of 3 seconds.

E. Provide an additional ~10% storage for additional space for bookmarked video.

F. Resolutions and Motion:

1. Cameras

a. 15 FPS
b. Max Camera Resolution
c. Always record during daytime hours (Monday – Friday, 6:00 AM to 6:00 PM)
d. After 6pm, motion recording set to interior cameras only, until 6:00 am Monday through Sunday.
e. Motion based recording at 40% motion
f. VBR with cap appropriate to resolution and quality
g. H.264 Main Profile Compression or H.265 acceptable

2.8 VMS LIVE VIDEO VIEWING

A. All cameras shall live stream at the following settings:

1. RTP/UDP
2. 30 frames per second (or maximum camera is capable of if less than 30)
3. Dynamic resolution (resolution of camera window on VMS client)

2.9 DIGITAL IP CAMERAS

A. General:

1. All cameras shall be compatible with the existing EMS ISD video management system.

2. All cameras shall be time synced to the Owner's NTP server.
3. The Contractor shall select the appropriate mounting hardware for the situation.
4. All cameras shall be equipped with remote autofocus or autoback focus with the exception of 180/360 degree cameras.
5. Multi-sensor 180 and 360 cameras shall have each sensor optimally calibrated independently to the conditions.
6. All cameras shall be vandal proof and appropriate for the environment it is being installed in.
7. All cameras shall have the latest firmware recommended by VMS that is being installed. All cameras of the same model shall have matching firmware versions.
8. The contractor shall coordinate with the owner for IP addressing, network configuration and multicast network configuration.
9. All cameras regardless of manufacturer/model shall have a consistent user name and non-standard password set. This shall be documented and provided to the owner and consultant prior to inspections
10. Cameras that require additional licensing are not acceptable.
11. The camera models below represent general performance criteria. Approved equals will have slight differences in specifications. The Owner and Consultant have complete discretion to reject approved equals that stray too far from the minimum requirements.

B. Camera Type 1

1. Indoor/Outdoor Fixed Lens 5MP Dome: Manufacturer and model:

a. i-Pro WV-X25500-V3LN
b. Or approved equal.

C. Camera Type 2

1. Outdoor Fixed Lens, 3 x 4K (25MP) 270° 3-sensor Dome: Manufacturer and model:

a. i-Pro WV-S8573L
b. Or approved equal.

D. Camera Type 3

1. Outdoor Fixed Lens, 4 x 4K (33MP) 360° 4-sensor Dome: Manufacturer and model:

a. i-Pro WV-S8574L
b. Or approved equal.

E. Mounting Hardware (may not be inclusive of all hardware required)

1. 5MP Dome

a. i-Pro wall mount bracket WV-QWL500-W

2. 33MP 4-sensor and 25MP 3-sensor Dome

a. i-Pro pole mount bracket WV-QPL500-W
b. i-Pro corner mount bracket WV-QCN500-W
c. i-Pro arm mounting bracket WV-QWL501-W
d. i-Pro arm mount camera adapter bracket WV-QSR503-W

3. Provide with all required options and accessories for a weathertight, secured mounting.
4. Provide stainless steel pole mounting hardware for cameras shown to be mounted on poles.

PART 3 - EXECUTION

3.1 TESTING

A. Refer to Section 27 00 00 for additional requirements.

B. Prior to energizing or testing the system, ensure the following:

1. All products are installed in a proper and safe manner per the manufacturer's instructions.
2. Dust, debris, solder, splatter, etc., is removed.
3. Cable is dressed, routed, and labeled; connections are consistent regarding polarity.
4. All products are neat, clean, and unmarred, and parts are securely attached.
5. Contractor shall ensure that each device in the security system is functioning normally and in such a manner as to meet the functional and performance requirements in this specification.

3.2 TRAINING

A. Refer to Section 27 00 00 for additional requirements.

B. Provide system operations, administration, and maintenance training by factory- trained personnel qualified to instruct.

1. Contractor shall provide up to 12 hours of scheduled and dedicated training time in three (3) four (4) hour sessions for administration and investigation.
2. Contractor shall provide up to 2 hours of scheduled and dedicated training time for maintenance including lens and dome cleaning, focusing and positioning.
3. Provide printed training materials for each trainee, including product manuals, course outline, workbook or student guides, and written examinations for certification.
4. Provide hands-on training with operational equipment.
5. Training shall be oriented to the specific system being installed under this contract as designed and specified.
6. Contractor shall provide all necessary documentation of system operating parameters prior to scheduled training sessions.

3.3 WARRANTY

A. Refer to Section 27 00 00 for additional requirements.

3.4 INSTALLATION PRACTICES

A. All services provided shall be professional and conform to the highest standards for industry practices. The Owner reserves the right to halt any installation due to poor workmanship. All work shall be defect free, and the installer shall replace, at their expense, any work found to be defective.

B. The Owner reserves the right to halt any installation due to failure of Contractor to observe installation-free periods due to instructional or administrative requirements. To the maximum extent possible, the Owner will provide advance notice of such periods.

C. Contractor is responsible for providing a complete and functional video surveillance system.

D. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.

E. Contractor shall follow these standards and approved submittals for locations of power supplies. The Owner intends to limit the number and location of power supplies to facilitate more effective long-term support and maintenance of the system.

3.5 COORDINATION

A. Contractor shall provide up to 8 hours (up to four, 2-hour sessions) of scheduled and dedicated coordination time to assist Owner with camera positioning and coordination as requested by Owner or Consultant.

3.6 AESTHETICS

A. All cables and equipment terminating at panels frames shall be vertically straight, with no cables crossing each other, from twelve inches inside the ceiling area to the termination block.

B. All cable bundles shall be combed and bundled to accommodate individual termination block rows and panels.

C. For any given telecom room, a horizontal and vertical alignment for all mounting hardware will be maintained to provide a symmetrical and uniform appearance to the distribution frame.

D. All surface-mounted devices shall be firmly secured level and plumb.

E. All rack mount equipment shall be securely installed.

3.7 HARDWARE LAYOUT

A. Hardware positioning and layout shall be reviewed and approved by the Owner prior to construction. The review does not exempt Contractor from meeting any of the requirements stated in this document.

3.8 VMS INSTALLATION PRACTICES

A. Verify that the manufacturer approved server hardware, OS meets the Owner's IT standards prior to ordering.

B. Coordinate server power, cooling, and mounting requirements with Owner prior to installation.

C. Coordinate virus scan/security software requirements with Owner and manufacturer prior to installation.

3.9 DEVICE CABLING/WIRING INSTALLATION PRACTICES

A. All external wire and cables shall be supported at least every five feet from the structure or as required to maintain not more than 12" cable sag between supports and without over tensioning the cables. Provide j-hooks as needed where cable tray or raceway is not available.

B. This Contractor shall coordinate installation with Division 27 05 00 cabling Contractor to ensure there is at least 2-inches of physical separation between security cabling and voice/data cabling throughout cable path. Voice/data cabling Contractor has first claim to cable tray.

C. All cables, regardless of length, shall be labeled within 18" of both ends with an identifier that is keyed to the door, room, or corridor number as identified.

D. All cables shall have 10-foot service loops neatly coiled above the camera location, or in the equipment room. During initial cable rough-in, this Contractor shall have sufficient slack to route anywhere within the equipment room.

E. Cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame. Cables shall be dressed in a neat and orderly fashion. Any cabling or equipment installation that is deemed unacceptable by the Owner or Consultant shall be replaced or corrected by the Contractor at no additional cost. Plastic zip ties are not allowed.

F. All cables are to run at right angles to the structure, placed above the ceiling in halls or corridors.

G. Cables shall not run above red iron joist.

H. Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests.

I. Ties and straps shall be installed snugly without deforming cable insulation. Ties shall be spaced at uneven intervals not to exceed four feet. No sharp burrs shall remain where excess length of the cable tie has been cut.

J. Contractor shall notify Owner immediately if obstruction or hazard is discovered in a pathway provided by others.

K. Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radiuses shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the manufacturer's rating.

L. No splices shall be installed in any cable.

3.10 CABLE TERMINATION

A. Termination hardware (blocks and patch panels) positioning and layout shall be reviewed and approved by the Owner prior to construction. The review does not exempt Contractor from meeting any of the requirements stated in this document.

3.11 INTEGRATION WITH PHYSICAL SECURITY SYSTEMS AND INTERCOM/PA SYSTEM

A. The video surveillance system shall be integrated with the Physical Security Systems and Intercom/PA system via an Ethernet interface with the minimum follow features.

1. Graphical floor plan maps showing icons of all cameras, intercoms and other integrated systems.
2. Camera views associated with intercom stations and doors.
3. Camera views linked to other camera views for seamless tracking of a subject throughout a facility.
4. Device names brought in from the integrated systems.
5. Database entries for all actions performed.
6. Time syncing via common NTP server.
7. Microsoft Active Directory integration.
8. Microsoft Exchange integration for email notifications.
9. Intercom audio recorded to VMS server synchronized with the associated camera.

B. The Contractor shall provide any and all licensing to integrate the systems together including any additional items to be added to the yearly maintenance agreement.

C. Refer to the individual specification sections for additional specific integration requirements.

D. The Contractor shall set up a meeting between the Owner, Consultant and manufacturer to determine the exact functionality of the integration before the integration starts.

3.12 FIRE STOPPING

A. Fire stopping of openings between floors, fire-rated walls, and smoke-rated walls, created by others for This Contractor to pass cable through, shall be the responsibility of the This Contractor. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.

B. Any openings created by or for This Contractor and left unused shall be sealed up by This Contractor.

C. This Contractor shall be responsible for creating a waterproof seal in and around any openings that This Contractor creates from the structure to the outside environment.

3.13 SYSTEM INSPECTION

A. Contractor shall coordinate with owner's representative for inspection after Contractor has completed testing of entire system.

B. Contractor shall have trained Contractor representative and testing equipment on site during inspection to assist with spot verification of tests.

C. Contactor shall verify with Project Representative the precise positioning of camera aim and shall make fine adjustments as requested.

3.14 LABELING

A. Contractor shall neatly label all security devices and cabling at both ends. All labels shall be on Project as-built drawings

B. Cameras are to be labeled per the AISD labeling format as specified in specification section 27 10 10 Voice and Data Distribution Cabling.

3.15 CAMERA INSTALLATION

A. Contractor shall field verify all camera locations and positioning with Owner prior to installation.

3.16 DOCUMENTATION

A. Upon completion of the installation, Contractor shall provide full documentation sets to the Consultant for approval as described in section 27 60 00. All documentation shall become the property of the Owner.

B. Documentation shall include the additional specific items detailed in the subsections below:

1. Contractor shall provide hard copy and electronic forms of the final test results.
2. Contractor shall provide a document including the following:
    a. Camera label/identifier
    b. Location of each drop by orientation/permanent landmark in the room
    c. Contractor shall provide accurate as-built Construction Drawings. The drawings are to include cable routes and device locations.

3.17 PRE-CHECKOUT

A. The Contractor shall demonstrate the following to Owner during system demonstration.

1. The cameras are fully installed and functional.
2. Camera adjustments are complete to the Owner's satisfaction including.
    a. Aim/Zoom
    b. Focus/Back Focus
    c. Dehumidification
    d. Masking Zones
    e. Motion Detection Zones
    f. Pre-Sets/Tours

3.18 FINAL ACCEPTANCE

A. In addition to closeout requirements in section 27 60 00, This Contractor shall demonstrate the following before final approval.

1. Owner training is complete.
2. Punch list items are complete.
3. As-built documentation is complete and submitted to Owner/Consultant.

3.19 EXTENDED WARRANTY

A. An extended warranty shall be part of the bid. The Contractor shall include price for a 2-year extended warranty (for a total of 3 years of support from time of final system acceptance) as part of proposal price. Contractor shall also provide a separate price for a 4th and 5th year of extended warranty.

3.20 FINAL PROCEDURES

A. Perform final procedures in accordance with section 27 60 00.

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, SK-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, SK-DUCTR with SK-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 keyed, remote test/reset switch in ceiling below detector and clearly readable from floor level. Provide with manufacturers optional accessory remote test/reset for ceiling mount, RTS151KEY.
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

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SECTION 28 31 13

IN-BUILDING TWO-WAY EMERGENCY RESPONDER RADIO COVERAGE ENHANCEMENT SYSTEM (ERCCS)

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes designing, furnishing, installing, and testing of a complete and operating Emergency Responder Radio Coverage Enhancement System. These specifications are provided to establish the scope and general operating characteristics of the system.

B. To guarantee integration performance and ongoing follow up support for the owner, the Emergency Responder Radio Coverage Enhancement System shall be designed, provided, installed and warrantied by a company meeting one of the two options:

1. The same licensed fire alarm contractor who is designing, providing, installing and warrantying the fire alarm system for this project.
2. Contractors with 5 or more years experience installing ERCCS systems in Class B, E and similar buildings. Proof of experience will be required in order to be considered.

C. The system shall comply with the requirements of UL2524 2nd Edition Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems, NFPA 72 2013 Edition, NFPA 1221 2016 Edition and IFC 2018 or later, as referenced.

D. The in-building two-way emergency responder communication enhancement system shall use a Honeywell signal enhancement system with UL2524 2nd edition listing from an Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratory (NRTL), NFPA 72, NFPA 1221 and IFC 2018 or later compliance. Alternate systems that communicate with the specified Notifier Fire Alarm System may be submitted for consideration given that the proposed system functions in like manner as the specified Honeywell system.

E. The In-building two-way emergency responder communication enhancement system must provide the following signal strengths:

1. Minimum DAQ of 3.0 or better and equivalent signal to interference noise ratio (SINR) applicable to the technology for either analog or digital.
2. Downlink - Minimum signal strength of -95 dBm throughout the coverage area.
3. Uplink - Minimum signal strength of -95 dBm received at the AHJ Radio System or as otherwise required by the AHJ.

F. The function is to provide full building coverage of the local first responders including the Fire Department, Law Enforcement, Emergency Services, etc. in the required band at the required signal strength that the Emergency Responder Radio System utilized by the Local AHJ.

G. The ERRCS system shall amplify Emergency Responder radio communications to provide 95% floor area radio coverage throughout the school, and within the following areas per state and local code:

1. Fire Command Center
2. Security room.
3. Elevators.
4. Elevator lobbies.
5. Emergency and Stand-by Generator Room(s).
6. Fire pump room(s).
7. Areas of refuge.
8. Inside enclosed exit stairways.
9. Exit passageways.
10. Standpipe cabinets.

11. Sprinkler sectional valve locations.
12. Other staging areas identified by the Fire Department.

H. The ERRCS shall provide monitoring of the essential system components as required by code to include not less than Antenna failure, Booster Failure, AC power supply failure, and system UPS failure.

I. Final acceptance and approval are required from the Fire Department in writing prior to contract closeout.

1.2 SCOPE

A. The system shall include a primary site with donor antenna, BDA, and all necessary components. Provide signal amplification to provide complete coverage in the building for the public safety agencies as required by the local AHJ (Authority Having Jurisdiction). System users shall receive and transmit radio signals from their portable radio units within the building. This shall be accomplished utilizing the following components:

1. Bi-Directional Amplifiers (Signal Boosters) / Fiber DAS Master & Remotes
2. Coaxial Cable / Fiber Cable
3. Antennas
4. Couplers
5. Connectors
6. Power splitters
7. Other components and interconnecting circuitry as required.

B. All tests shall be conducted, documented, and signed by a person in possession of an FCC General Radio Telephone Operators License. All testing personnel shall be certified and authorized by the signal booster manufacturer in the installation and operation of their equipment. Personnel qualifications must be acceptable to the AHJ.

C. Antenna isolation shall be maintained between the donor antenna and all inside antennas (DAS) to a minimum of 20dB under all operating conditions.

D. The system design shall be based on the Honeywell line of Public Safety Signal Boosters / Fiber DAS or equivalent UL2524 2nd Edition, NFPA 72, NFPA 1221, IFC and FCC certified to establish standards of quality for materials and performance. The naming of a specific manufacturer or a catalog number does not waiver any requirement or performance of individual components described in the specifications.

E. Antenna isolation shall be maintained between the donor antenna and all inside antennas (DAS) to a minimum of 20dB under all operating conditions.

F. This system is stand-alone, in the sense that it is not connected to a larger or multi-site system. The system provided shall provide service to this campus only.

G. Each floor of the building shall be divided into a grid of 20 approximately equal areas. These areas provide the basis for measurement and test acceptance as defined in Part 3 “Execution”, Section 6 “Testing”, item I “Final Acceptance Testing” in this document.

H. Proposer shall perform a site survey prior to determine radio quality levels and provide a solution appropriate for the actual RF conditions at the site. A formal, documented review of this initial survey shall be submitted with the proposed solution.

I. The proposed solution shall include any additional cabling necessary (fiber optic or unshielded twisted pair) that connects the BRCCS to the campus data network.

J. The proposed solution shall include all cabling for connecting the various components together, such as the BDA and the individual antennas, etc.

K. The scope includes all fiber jumpers and other connecting cables for a complete and operational system.

L. The scope includes new power outlets with branch circuitry as needed for the solution.

M. The scope includes all required cabling pathways above accessible ceilings and fixed conduit pathways in exposed areas. The proposed pathways shall be coordinated with the General Contractor, Architect, and Consultant, with the goal of leveraging any available and appropriate pathways for multiple use.

1.3 RELATED DOCUMENTS

A. Obtain, read and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

B. IFC2015: International Fire Code, 2015 edition

C. The following codes, associations, acts and agencies, as required by law:

1. Americans with Disabilities Act (ADA)
2. Federal Communications Commission (FCC)
3. National Electric Code (NEC)
4. National Electrical Safety Code (NESC)
5. National Fire Protection Association (NFPA)
6. Occupational Safety and Health Administration (OSHA)

D. The following standards:

1. American National Standards Institute (ANSI)
2. American Society of Testing Material (ASTM)
3. National Electrical manufacturers Association (NEMA)
4. Telecommunications Industries Association (TIA)
5. Electronic Industries Association (EIA)
6. Institute of Electrical and Electronics Engineers (IEEE)
7. Underwriters Laboratories (UL)
8. American Standards Association (ASA)

E. The following guidelines:

1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.4 SUBMITTALS

A. Include the building elevation depicting the location of outdoor antenna associated with the proposed system. Include height of antenna centerline above building, orientation, and location of all external grounding connections.

B. Include a plan view of each interior floor where indoor antenna systems are proposed. Include antenna numbers, coaxial cable routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. All components shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating a –95 dBm downlink (base to mobile) signal strength around each proposed indoor coverage antenna. Include results of any previous coverage testing per grid, if available.

C. Provide schematic diagram of each system including references to submitted equipment.

D. Specify antenna grounding and surge protection in accordance with NEC Article 810.

E. Specify the backup power source (Life Safety) and include calculations to ensure the backup power requirements as specified in this standard are met.

F. Equipment Specification Sheets - Provide copies of manufacturer specification sheets of all system components.

G. Submit product certificates signed by the manufacturer of radio system components certifying that their products comply with specified requirements.

1.5 QUALITY ASSURANCE

A. Certification: All work must be commissioned, tested, and certified by a current Factory Authorized Integrator of the Manufacturer for Factory Warranty. As part of the submittal packet, provide a current letter from the manufacturer that the Commissioning Integrator of Record is a current Factory Authorized Integrator for the Honeywell ERCCS. Contractors submitting alternate systems for consideration must meet the same qualifications, including factory authorized credentials, from the Manufacturer of proposed alternate system.

B. Training: Instruct Owner's personnel in the operation of the system at the Owner's convenience. Provide letter of certification of Owner's instructional periods, stating names of instructor and names of Owner's representatives.

1. Note: All bids shall include the following verbiage in their Bid Proposal which states that, if awarded, the Communications Integrator will provide virtually unlimited end user training for the life of the system at no additional charge.

C. Installer Qualifications: Engage an experienced factory-authorized installer to perform work of this Section.

D. Single-Source Responsibility: Obtain radio system components from a single source who assumes responsibility for compatibility of system components.

E. Installation shall conform to the requirements of the NFPA 101, Life Safety Code, as well as Local Code and Building Authority requirements.

F. Comply with NFPA 72, and all local codes.

G. All equipment shall be UL listed and labeled, and in accordance with applicable NEMA and ANSI Standards.

PART 2 - PRODUCTS

2.1 GENERAL PERFORMANCE REQUIREMENTS

A. The system design, and installation, shall in no case exceed the FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields". System Characteristics:

B. Signal Strength

1. Downlink. A minimum signal strength of -95 dBm shall be provided throughout the coverage area.
2. Uplink. A minimum signal strength of -100 dBm received at the City/County/Municipal Radio System from the coverage area.

C. Permissible Systems

1. The ERRCS system shall utilize a fixed distributed antenna system (DAS) in each coverage building with fiber remote for in-building amplification.
2. The DAS component shall utilize a combination of coaxial trunks/radials and/or fiber trunk/radials with fiber node units.

D. The digital signal booster shall be capable of field configuration via programmable software for the frequency channels with adjustable bandwidths as specified by the AHJ.

E. 700MHz & 800MHz + FirstNet Band 14, VHF, UHF signal boosters shall support both Class A and Class B operation. Signal boosters shall be channel selective type with 150KHz, 100KHz, 75KHz, 62.5KHz, 50KHz, 37.5KHz, 25KHz, and 12.5KHz. channel bandwidth options. Non-selective wide-band signal boosters shall not be accepted, unless required to cover multiple channels within the same band.

F. Signal Boosters shall have oscillation suppression circuitry to protect the public safety radio system in case of system malfunction or other causes. This signal booster circuitry shall allow real time automated oscillation correction and immediate detection capable of generating an oscillation alarm, combined with programmable limited operation or auto-shutdown if performance migration fails.

G. Signal Boosters must have uplink noise suppression function to eliminate uplink noise while in standby (i.e. no radio transmission from within a building). Systems that produce any measurable level of uplink noise while in standby shall not be acceptable.

H. Signal booster must have uplink, and downlink squelch per channel per timeslot.

I. Signal Booster gain shall be rated at minimum of 85dB +/- 2.0dB and the gain shall be adjustable in a minimum of 28dB range. System gain shall be set and documented at the time of the final system test.

J. Maximum propagation delay of the signal booster system shall be adjustable in the signal booster to comply with system requirement or as specified by the AHJ. Signal booster shall offer filter delay options. Maximum propagation delay shall be within the minimum Range of 3.5µS (microseconds) to a maximum of 61.5µS (microseconds).

K. Signal Booster shall produce no more than a maximum of 9dB noise throughout its published operable uplink gain range.

L. The signal booster system shall include built-in automatic supervision of malfunctions of the signal booster and battery systems as per NFPA 1221, NFPA 72 and IFC. Non-OEM equipment add-ons and modifications to comply with this specification shall not be acceptable.

M. A dedicated supervised monitoring/annunciator panel shall be provided within the emergency command center next to the fire alarm panel / annunciator or other location as designated by AHJ to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:

1. Normal AC power
2. Signal booster trouble
3. Antenna Failure
4. Loss of normal AC power
5. Failure of battery charger
6. Low battery capacity
7. Active System component failure

N. Signal booster shall meet Buy American compliance requirements.

O. For signal booster to be supervised by any FACP, the signal booster system shall be Honeywell branded model with universal normally open relays for connection to external monitoring modules.

P. External filters, duplexers, power supplies or other non-OEM additions or modifications of the original equipment shall not be acceptable with the exception where technically required so long as it does not violate the UL2524 2nd edition certification. If required, the external filters should be manufactured or certified by the manufacturer.

Q. All signal booster components shall be contained in a type-4 approved waterproof enclosure. All enclosures shall be painted red with external labeling as required by the AHJ.

R. Reject filters: Notch filter sections shall be incorporated to minimize adjacent channel cellular and SMR (Nextel) degradation of the signal booster performance. The minimum downlink band adjacent band rejection shall be 35 dB or greater at system coverage bands/channels.

S. Band Migration Capability: The signal booster shall include re-tunable or replaceable filters to accommodate rapid and economic passband changes in the event of mandatory FCC changes within the NPSPAC band. The use of non-adjustable and non-replaceable RF input and output filters is prohibited.

T. Output Level control: An automatic output leveling circuit shall be included for both passbands with a minimum dynamic range of 60 dB, less any gain reduction setting, to maintain FCC out of band and spurious emission compliance.

U. Degraded performance in emergencies: The system shall be designed to allow degraded performance in adverse conditions, such as abnormally high temperatures resulting from nearby fires, extreme voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, etc.) shall not be implemented as the standard mode for public safety applications. It is the purpose of this specification to assure the maximum possible level of communications to public safety personnel depending upon the signal booster even to the extent of damaging the signal booster as long as some communications benefit can be provided during the emergency.

V. Mode of Operation: The system shall be normally powered on and shall continuously provide passing of frequencies within the Public Safety and First Responder bands. I. The system as installed must comply with all applicable sections of FCC Rules Part 22, Part 90 and Part 101.

W. Active Equipment (Signal Boosters and Bidirectional Amplifiers) Shall meet FCC Requirements.

1. Donor Antenna

   a. Antenna - Provide an outdoor rated, YAGI antenna, 746-896MHz, 11dBi, 8 element antenna with hermetically sealed driver unit and stainless steel hardware. Provide antenna with mast mounting hardware.
   b. Mount – Provide a non-penetrating roof mount with concrete block ballasting as required. Provide 2” pipe mast for mounting of antenna. Provide unit with rubber base pad. Coordinate final roof location with existing conditions and verify adequate roof support for load.
   c. Grounding – Ground antenna, mast and roof mount as required by NEC.
   d. Surge Protection – Provide Broadband, bi-directional surge arrestor on antenna lead into system.
   e. Down Conductor – LMR-600, outdoor rated cabling with required connectors and terminations.
   f. Antenna shall be mounted as to withstand winds up to 70 mph.
   g. Basis of Design – Westell CSI-AY/746-896/11 or approved equivalent.

2. Bi-Directional Amplifier

   a. Amplifier - Digital Signal Booster operating in the 800 MHz range (Bid Option for dual band 700/800 MHz) with up to 1-60 programmable digital filters for both uplink and downlink. Filter center frequency and characteristics are fully programmable. Filter bandwidth is user programmable from 6.25 kHz to 15 MHz. All state-of-the-art product components are protected by a NEMA 4 style enclosure to meet the demands of the NFPA requirements. Intuitive web browser interface allows booster to be easily configured for changing RF environments.

      1) Channel power shall be as required based upon final system configuration and contractor measured RSSI at donor antenna site.
      2) Basis of design: Comb Critical Point Public Safety Bi-Directional Amplifier approved equivalent. Model/size based on need determined by site survey.

   b. Power Supplies: At least 2 independent and reliable power supplies shall be provided, one primary and one secondary.

1) The primary power source shall be supplied from a dedicated 20 ampere emergency branch circuit and comply with 4.4.1.4 of NFPA 72.
2) The secondary power source shall be a dedicated battery, capable of operating the ERRCS for at least 24 hours of 100% system operation. The battery cabinet shall be supplied from a dedicated 20 ampere emergency branch circuit and shall automatically charge in the presence of external power input.
3) Basis of design: Newmar PE Series Power Enclosure or approved equivalent. Model/size based on need determined by site survey.

c. Cabinet

1) The signal booster and all associated RF filters shall be housed in a single, NEMA 4x certified, painted steel weather tight box (Color Fire Engine Red). The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. Operating temperatures: –22 deg F to +120 deg F (–30 deg C to +50 deg C) minimum temperature range, including microprocessors. Provide label on front of cabinet “Emergency Responder Radio System”.
2) The battery/charger system and all associated equipment shall be housed in a single, NEMA 4x certified, painted steel weather tight box (Color Fire Engine Red). The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. Operating temperatures: – 22 deg F to +120 deg F (–30 deg C to +50 deg C) minimum temperature range, including microprocessors. Provide label on front of cabinet “Emergency Responder Radio System-Battery Cabinet”.

d. Monitoring: The ERRCS shall provide the NFPA 72 required minimum alarm supervisory and trouble points including the following:

1) Malfunction of the Signal Booster(es)
2) Malfunction of the Power Supply(ies)
3) Antenna Malfunction
4) Low battery capacity (70% of the 12 hour capacity has been depleted)
5) Loss of normal AC power
6) Failure of battery charger
7) The following system trouble/fault conditions shall be annunciated at a minimum:
    a) Antenna Malfunction
    b) Signal Booster malfunction
    c) Low battery capacity of UPS
    d) Loss of normal AC power
    e) Loss of emergency AC power (UPS activated)
    f) AC power supply failure within signal booster assembly.
8) Monitoring the integrity of power supplies shall be in accordance with requirements of the local code.
9) The system shall have primary fault monitoring through the existing Fire Alarm System.
    a) Secondary fault monitoring shall be provided by interface with existing Building Automation System and/or data network monitoring system.
10) The Supervision Alarm(s) shall not be cancelled until the trouble / fault has been corrected and the System has been restored to normal operation.
    a) Provide one (1) complete unit at the site and provide a maintenance/repair kit to be turned over to owner.

e. Distributed Antenna System (DAS)

1) Interior Antenna

a) Omni-Directional - Wall or ceiling mount, above accessible ceiling, pendant mount in exposed ceiling, Omnidirectional In-building Antenna, 698–960 MHz.
   (1) Beamwidth, Horizontal 360° omnidirectional
   (2) Beamwidth, Vertical 80°nominal
   (3) Gain at Frequency Band 1.5 dBi @ 698–800 MHz
   (4) Impedance 50 ohm
   (5) Input Power, maximum 50 W
   (6) Operating Frequency Band 698 – 800 MHz
   (7) Polarization Vertical
   (8) Return Loss 10.9 dB
   (9) VSWR 1.8:1
   (10) Plenum rated assembly.

b) Patch-Directional
   (1) Gain, dBi 5.0
   (2) Beamwidth, Horizontal, degrees 90
   (3) Beamwidth, Vertical, degrees 65.0
   (4) VSWR | Return Loss, dB 1.5 | 14.0
   (5) Input Power per Port, maximum, watts 50
   (6) Polarization Vertical
   (7) Impedance 50 ohm

c) Provide quantity and locations of antennas.

d) Provide five (5) spare indoor above ceiling antenna units with mounting hardware and turn over to owner.

e) Basis of design: Pulse model DASUTLC500NF or approved equivalent.

2) Cabling

a) In-building - AL4RPV50 - HELIAX® Plenum Rated Air Dielectric Coaxial Cable, corrugated aluminum, 1/2 in, off white PVC jacket.

b) Tunnel - AVA5RK-50FX, HELIAX® Coaxial Cable, corrugated copper, 7/8 in, black, Non-halogenated, fire retardant polyolefin jacket.

3) Connecting Hardware

a) L4TNM-PSA, Type N Male Positive StopTM for 1/2 in AL4RPV50, LDF450A cable

b) 2, 3, and 4-way low power splitters, 698MHz to 2700MHz rated. Loss, tap and isolation values as required by final system configuration.

4) Passive Equipment: Passband shall be 700/800 Mhz, IP rating of 2 Ghz.

5) Cable: Passband shall be 700/800 MHZ. All interior Cable shall be rated for fire plenum.

6) Spare – Provide a total of five (5) additional indoor omni-directional antennas including all costs for installation and 250’ of cabling. Units to be placed during construction if required for correction of coverage issues. Antenna units not required after project is complete to be turned over to owner for attic stock.

f. Miscellaneous Cabling / Connectivity

1) Fiber optic cabling

a) Provide re-termination of existing singlemode fiber optic strands with angle polished LC connectors as indicated on the drawings.

b) Provide duplex fiber jumpers, compatible with fiber cable plant and system input/output connectors for a complete and fully operational system.

2) Copper (data) – Provide CAT 6 data patch cables for all connections of network enabled equipment within the system.

3) Coaxial – Provide coaxial cable equipment jumpers and connectors required for a complete and fully operational system.

g. Licensing

1)All fees associated with the licensing shall be paid by the Contractor.
2)All testing must be done on frequencies authorized by the FCC. A valid FCC license will be required if testing is done on frequencies different from the police, fire or emergency medical frequencies.

h. Approval and Testing Procedures

1)Design Approval: Plans shall be submitted and approved prior to installation. The following information shall be provided to the local Fire Department unit representative by the system designer / Contractor:

a) A minimum of 3 copies of the RF site survey results and of the proposed solution.
b) A minimum of 3 copies of detailed drawings showing the location of the donor antenna with elevation information, amplification equipment and associated antenna systems which includes a view showing building access to the equipment.
c) A minimum of 3 copies of schematic drawings of the electrical system, backup power, antenna system and any other associated equipment relative to the amplification equipment including panel locations and labeling.
d) A minimum of 1 copy of the Manufacturer's data sheets on all equipment to be installed.

2)The local Fire Department will review plans and specifications. Upon acceptance, plans will be stamped to indicate approval. Stamped plans are required to be present at the acceptance test. Any field changes that occur during construction shall be incorporated into new As-Built plans, including any manufacturer's data sheets for any equipment changes not submitted in the original submittal. As-Built plans, if required due to system changes, shall be submitted to the local Fire Department for approval.

i. Maintenance and Annual Testing

1)Annual tests will be conducted by the proposer or district authorized company.

a) The 1st year re-testing will be done at no expense to the Owner or the appropriate emergency services departments as required in the original testing procedures.
b) Service Contract

j. Optional Service Contract – The following represents recommendations for a service contract that shall be made available to the owner for purchase outside the scope of this project.

1)Provide Budgetary pricing to include:

a) Upgrades to system as directed by the Fire Department.
b) Maintenance contract with a Radio Service Provider in place with name of authorized company, who will provide a 24 hour by 7 day emergency response within two (2) hours after notification. The system shall be maintained in accordance with FCC requirements.
c) All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radiotelephone Operator License, or a technician certification issued by the Association of Public-Safety Communications Officials International (APCO) or equivalent as determined by the Fire Department.
d) Maintain a list of contact personnel with phone numbers at the radio repeater system cabinet. The contact personnel shall have knowledge of the building and the repeater system and be available to respond to the building in the case of an emergency.
e) Radio Service Provider maintenance contract shall include but not limited to:

2)Annual Test

a) All active components of the distributed antenna system, including but not limited to amplifier, power supplies, and back- up batteries, shall be tested a minimum of once every 12 months.
b) Amplifiers shall be tested to ensure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
c) Back-up batteries and power supplies shall be tested under load for a period of 1 hour to verify that they will operate during an actual power outage.
d) Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
e) Documentation of the test shall be maintained on site and a copy forwarded to the Fire Department Radio Supervisor upon completion of the test.

3)Five Year Test

a) In addition to the annual test, a radio coverage test shall be conducted a minimum of once every 5 years to ensure that the radio system continues to meet the requirements of this ordinance. The procedure set forth in NFPA 72 shall apply to such tests.
b) Fire Department Radio personnel, after providing reasonable notice to the Owner or their representative, shall have the right to enter onto the property to conduct field testing to be certain that the required level of radio coverage is present.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. The Proposer shall submit a full submittal, including plans and all equipment manufacturer sheets, to the Fire Marshal's Office for review. There is a plan review fee and a permit fee. These fees shall be included in proposal and paid by the Proposing Vendor.

B. Install systems in accordance with UL, NEC, and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system.

D. Perform all work under the onsite supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and Owner approval. Only factory certified personnel of the installing contractor or manufacturer shall train the Owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

E. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

F. The owner reserves the right to halt any installation due to failure of contractor to observe installation-free periods due to instructional or administrative requirements. To the maximum extent possible, the owner will provide advanced notice of such periods.

G. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.

H. Contractor shall follow these standards and approved submittals for locations of power supplies. The Owner intends to limit the number and location of power supplies to facilitate more effective long-term support and maintenance of the system.

3.2 INSTALLATION

A. ERRCS wiring shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all Local, State and National codes. This contract shall be responsible for designing, furnishing, and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

B. Provide fire stop material and seal all cable penetrations in the building.

C. All wiring between devices shall be run open wired above accessible ceilings in cable tray. Where cable tray systems are in place and there is adequate capacity to install the ERRCS wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractors on site.

D. Where pathways do not exist for ERRCS wiring, this contract shall be responsible for providing all required conduit to support communications cabling to meet building codes and manufacturer’s recommendations.

E. Cables shall not be run exposed in any area unless installed in cable tray.

F. All cabling installed in cable trays in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

G. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

H. ERRCS System Signal Wires and Cables

1. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.
2. Routing and Interconnection
    a. Wires or cables routed between consoles, cabinets, racks, and other equipment shall be installed in an approved conduit or cable tray that is secured to building structure.
    b. Completely test all of the cables after installation and replace any that are found to be defective.

        1) Install cables without damaging conductors, shield, or jacket.
        2) Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
        3) Pull cables without exceeding cable manufacturer's recommended pulling tensions.

I. Product Delivery, Storage, and Handling

1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment model and serial identification numbers.
2. Store and protect equipment in a conditioned space until installation.

J. System Installation

1. Coaxial antenna cabling shall not be installed in the same conduit, raceway, or cable trays used for other systems.
2. All equipment shall be connected according to the OEM's specifications to ensure correct installation and system performance.
3. Coordinate all roof penetrations with Owner’s Roofing Contractor.

3.3 GROUNDING

A. Ground cable shields and equipment per Manufacturer’s requirements.

B. Antenna mast shall be grounded per NFPA 70 NEC requirements and antenna manufacturer's requirements. Provide grounding blocks and surge protection for coaxial cabling. Bond antenna mast to main building ground or TMGBB in MDF.

3.4 IDENTIFICATION / LABELING

A. All cabling shall be identified at each end indicating its source and destination.

B. Antennas shall be given unique identification labels that are applied at the unit and recorded in the as-built drawings.

3.5 SYSTEM START-UP

A. System start-up shall be performed by the contractor prior to request for system testing. Start-up shall be coordinated with owner and Sinclair Police in the event that the activation of the new ERRCS introduces unwanted noise or interference to the existing radio systems in the surrounding area.

B. After completion of the installation, the contractor shall request an initial acceptance test by the Owner and Engineer.

3.6 TESTING

A. Upon completion of the system installation, programming and initial start-up, the contractor shall be responsible for providing performance acceptance testing. This testing shall be scheduled and performed in the presence of the Owner and the Engineer.

B. All signal measurement acceptance testing shall be performed by the contractor with their own equipment, by qualified personnel who have specific training and familiarization with the test equipment, and with test equipment which have been calibrated within the previous 3 months. Signal measurement results shall be stored electronically and presented with final system documentation including information pertaining to the location of each of the signal measurement tests.

C. All signal quality and performance acceptance testing shall be performed with local Fire Department radios. Coordinate with the local Fire Department to acquire a test set (properly tuned and calibrated) for use during the acceptance testing.

D. Tests shall be made using frequencies close to the frequencies used by the Fire Department and appropriate emergency services. If testing is done on the actual frequencies, then this testing must be coordinated with the local Fire Department unit. All testing must be done on frequencies authorized by the FCC. A valid FCC license will be required if testing is done on frequencies different from the police, fire or emergency medical frequencies.

E. System shall provide a 95% coverage guarantee at a Delivered Audio Quality (DAQ) level of 3.4, based on the DAQ scale as defined in TIA TSB-88. A summary of this scale is:

1. Delivered Audio Quality (DAQ): Scale Definitions
2. Delivered Audio Quality: Subjective Performance Description
3. DAQ 5.0: Speech easily understood.
4. DAQ 4.5: Speech easily understood. Infrequent Noise/Distortion.
5. DAQ 4.0: Speech easily understood. Occasional Noise/Distortion.
6. DAQ 3.4: Speech understandable with repetition only rarely required. Some Noise/Distortion.
7. DAQ 3.0: Speech understandable with slight effort. Occasional repetition required due to Noise/Distortion.
8. DAQ 2.0: Understandable with considerable effort. Frequent repetition due to Noise/Distortion.
9. DAQ 1.0: Unusable, speech present but unreadable.

F. Testing Procedures

1. Measurements shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.

G. Pre-Testing: The radio system shall be pre-tested to ensure that two-way coverage on each floor of the building meets the minimum coverage described above.

H. Final Acceptance Testing

1. All acceptance testing shall be done in the presence of a Fire Department representative at no expense to the owner/Fire Department.
2. Small scale drawings (11 inch x 17 inch maximum) of the structure shall be provided by the Contractor. The plans shall show each floor divided into the grids as described above, and the results of the pre-testing. Each grid shall be labeled to indicate the DAQ result from the final acceptance testing.
3. The Contractor shall provide the latest approved plans for the system, including any manufacture's data sheets for any equipment changes not submitted in the original submittal.

I. The ERRCS shall be tested to ensure that the two-way coverage on each floor of the building meets the requirements of the local code and at a minimum covers 95 percent of general building areas and 99% of building Critical Areas. The test procedure shall be conducted as follows:

1. Each floor of the building shall be divided into a grid of 20 approximately equal areas.
2. The test shall be conducted using a calibrated portable of the latest brand and model used by the agency talking through the agency's radio communications system.
3. A maximum of two non-adjacent areas shall be allowed to fail the test.
4. In the event that three of the areas fail the test, in order to be more statistically accurate, the floor may be divided into 40 equal areas. A maximum of four nonadjacent areas shall be allowed to fail the test. If the system fails the 40-area test, the system shall be altered to meet the 90-percent coverage requirement.
5. A test location approximately in the center of each grid area shall be selected for the test, then the radio shall be enabled to verify two-way communications to and from the outside of the building through the public safety agency's radio communications system. Once the test location has been selected, that location shall represent the entire area. If the test fails in the selected test location, that grid area shall fail, and prospecting for a better spot within the grid area shall not be allowed.
6. The gain values of all amplifiers shall be measured, and the test measurement results shall be kept on file with the building owner so that the measurements can be verified during annual tests. In the event that the measurement results become lost, the building owner shall be required to rerun the acceptance test to re-establish the values.
7. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at the time of installation and subsequent annual inspections.

J. Training

1. Training shall include a complete working demonstration of the ERRCS. Training and Demonstration shall not be executed until after successful system testing as outlined above.
2. A minimum of eight (8) hours of training shall be included in the contract. Demonstrate purpose, adjustment, operation, and maintenance of the system including each component and control.
3. Review binder containing instructions and equipment and systems data.
4. Technical training sessions which shall include hands-on training, accompanied by full system documentation and system as-built drawings.
5. Training shall include any documentation and hands-on exercises necessary to enable operations personnel to assume full operating responsibility or the ERRCS after completion of the training period.

K. O&M Manuals and As-Built Drawings

1. Provide three (3) copies of all approved shop drawings.
2. Provide owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information.

Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

3. Provide three (3) copies of Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions. As-built drawings shall include the following:

    a. Locations of all active and passive equipment
    b. Cable routes
    c. Location of any "dead spots" as uncovered in the system testing.

        1)Provide three (3) copies of system schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types and the gain values of all amplifiers.
        2)Warranty: Provide statement of warranty with O&M manuals.

L. Warranty

1. Provide a one (1) year contractors full warranty and complete Service/Maintenance program in compliance with code required system maintenance/service of the system, including equipment, and wiring against defects in material and workmanship from the date of system completion and final acceptance. If any defects in materials, workmanship or operational failures are experienced within the warranty period promptly correct at no extra cost to the Owner for parts or labor. Provide statement of warranty with O & M manuals.
2. Make available an additional one-year service contract offering continuing factory authorized service and code required testing/maintenance of this system after the initial warranty period. Provide estimated cost of this service contract within the proposal.
3. Contractor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of any system component inhibiting access to an entire building.
4. Within the warranty period, if equipment cannot be repaired with 24 hours of service visit, the Contractor shall provide "loaner" equipment to the Owner at no charge.
5. Proper identification is required and must be visible while on-site for warranty/service calls. Provide notification of completion to the Owner prior to departing the site.

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 6”, and stockpile for placement (6” minimum) 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.

3. Unsuitable Materials: Topsoil or unclassified fill will be declared as "unsuitable" if any of the following conditions or matter and particles are present to a degree that is judged detrimental to the proposed use of the material:

   1. Moisture.
   2. Decayed or un-decayed vegetation.
   3. Hardpan clay, heavy clay, or clay balls.
   4. Rubbish.
   5. Construction rubble.
   6. Sand or gravel.
   7. Rocks, cobbles, or boulders.
   8. Cementitious matter.
   9. Foreign matter of any kind.
   10. Unsuitable materials shall be disposed of as "waste".

4. Wet Material: If fill material is unsatisfactory for use as embankment solely because of high moisture content, the Architect may grant the Contractor permission to process the material to reduce the moisture content to a usable optimum condition.

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 of 0 to 4% of optimum moisture content. Reference the Geotech Report.

J. Scarify general subgrade soils in place to a depth of 6inches and recompact. Compact to at least between 93 and 98 percent of Standard Proctor in accordance with ASTM D698 (Standard Proctor), at a moisture content of +2 to +6% of optimum moisture content. Reference the Geotech Report.

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 6" 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 two percentage points above (+2%) its optimum moisture content and compacted to at least 95% 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.
   5. 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.
   2. 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), moisture content of 0 to 4% of optimum moisture content. Scarify general subgrade soils in place to a depth of 6 inches and recompact. Compact to between 93% and 98% of Standard Proctor in accordance with ASTM D698 (Standard Proctor), at a moisture content of +2 to +6% of optimum moisture content. Compact non-granular or sand-like material to at least 95 percent of Standard Proctor within 2 percentage points below to 1 percentage points above of optimum.

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----------Between 93% and 98%
   c. Material under building----------Per Geotechnical Report and Building Subgrade Preparation

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.
   2. 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 was an existing administration campus and consist also of an active middle school campus, 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.

C. 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 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 30 00 – Sanitary Sewerage Utilities
   4. 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 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 RCB/RCP/HDPE storm sewers shall be as specified in Section 501.6, 501.23, 504 and 508 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 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 at least 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. If slab-on-grade is used, do not remove vapor retarder.

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 29 – Testing Agency 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/ft³).

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. Stabilization for Paving Subgrade

1. Hydrated Lime: Type B (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 7% by weight at rate per the lime series test per SY and a "free" water content not exceeding 4% by weight

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 12" outside perimeter of paving.

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 B 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 12” beyond sidewalk edge or per the plans, whichever is greater.

C. Placing Lime: Add lime to the scarified material in an amount based on the lime series testing 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 the 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 within the range of 0 to 4 percentage points above optimum. 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 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.
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.
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 two piers, 1’ – 0” of additional drilling on one pier and 1’ – 0” less drilling on a second pier would result in a net 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. 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 8 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 within top 40 feet of pier.
2. Except as otherwise required, vertical reinforcing may be spliced 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 8 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

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 00 - Concrete Forming and Accessories.
   2. Section 03 30 00 - Cast-in-Place Concrete.
   3. Section 07 13 26 - Self-adhering Sheet Waterproofing.
   4. Division 22 - Sub-soil drainage system.
   5. Section 31 23 00 - Excavation and Fill.
   6. Section 31 23 13 - Building Subgrade Preparation.

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 220": 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)
      c. “Flow 15-P”: Polyguard, Ennis, Texas (972-875-8421)
   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 00 - EXCAVATION AND FILL)
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 and Fire Lanes)
      c. 7” thick – 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 I (sidewalks/flatwork) and II (pavement).

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 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-115F 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 60 00 - PRODUCT REQUIREMENTS.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Traffic Paint: Fed. Spec. TT-P-115F, 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 Sherwin Williams, 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 17 26

TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Cast-In-Place detectable/tactile warning surface tiles where indicated at curb ramps.

B. Related Sections:
1. Section 03 30 00 - Cast-in-Place Concrete.
2. Section 32 13 13 - Concrete Paving.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.

B. Samples for Verification Purposes: Submit two (2) tile samples minimum 6"x6" of the kind proposed for use.

C. Shop drawings are required for products specified showing fabrication details, composite structural system, tile surface profile, sound on cane contact amplification feature, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.

D. Material Test Reports: Submit complete test reports from qualified accredited independent testing laboratory's to qualify that materials proposed for use are in compliance with requirements and meet or exceed the properties indicated on the specifications. All tests shall be conducted on a Cast In Place Detectable/Tactile Warning Surface Tile system as certified by a qualified independent testing laboratory and be current within a 24 month period.

E. Maintenance Instructions: Submit copies of manufacturer's specified installation and maintenance practices for each type of Detectable Warning Surface Tile and accessory as required.

1.3 QUALITY ASSURANCE

A. Provide Cast In Place Detectable/Tactile Warning Surface Tiles and accessories as produced by a single manufacturer with a minimum of three (3) years experience in the manufacturing of Cast In Place Detectable/Tactile Warning Surface Tiles.

B. Installer's Qualifications: Engage an experienced Installer certified in writing by Cast In Place Detectable/Tactile Warning Surface Tile manufacturer as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for Project.

C. Americans with Disabilities Act (ADA): Provide Surface Applied Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title III Regulations,28 CFR Part 36 ADA STANDARDS FOR ACCESSIBLE DESIGN, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).

1.4 DELIVERY, STORAGE, AND HANDLING

A. Cast In Place Detectable/Tactile Warning Surface Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.

B. Cast In Place Detectable/Tactile Warning Surface Tiles shall be delivered to location at building site for storage prior to installation.

1.5 SITE CONDITIONS

A. Environmental Conditions and Protection: Maintain minimum temperature of40°F in spaces to receive Cast In Place Detectable/Tactile Warning Surface Tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

B. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public.

1.6 WARRANTY

A. Cast In Place Detectable/Tactile Warning Surface Tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, fading and loosening of tiles.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vitrified Polymer Composite (VPC): Provide Armor-Tile as manufactured by Engineered Plastics Inc., Tel: 800-682-2525. Cast In Place Detectable/Tactile Warning Surface is an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.9" base diameter, and 0.45" top diameter, spaced center-to-center 2.35" as measured on a diagonal and 1.67" as measured side by side. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90° raised points 0.045" high, per square inch.
   1. Color: As selected by Architect.
   2. Dimensions: Cast In Place DetectablelTactile Waming Surface Tiles shall be held within the following dimensions and tolerances:
      a. Length and Width: 12x12 or 24x24 nominal.
      b. Depth: 1.375 (1-3/8") (+/-) 5% max.
      c. Face Thickness: 0.1875 (3/16") (+/-) 5% max.
      d. Warpage of Edge: 0.5% max.
      e. Embedment Flange Spacing: shall be no greater than 3.1".
   3. Water Absorption of Tile when tested by ASTM D 570-98 not to exceed 0.05%.
   4. Slip Resistance of Tile when tested by ASTM C 1028-96 the combined Wet and Dry Static Co-Efficients of Friction not to be less than 0.80 on top of domes and field area.
   5. Compressive Strength of Tile when tested by ASTM D 695-02a not to be less than 28,000 psi.
   6. Tensile Strength of Tire when tested by ASTM D 638-03 not to be less than 19,000 psi.
   7. Flexural Strength of Tile when tested by ASTM D 790-03 not to be less than 25,000 psi.
   8. Chemical Stain Resistance of Tile when tested by ASTM D 543-95 (re approved 2001) to withstand without discoloration or staining -10% hydrochloric acid, urine, saturated calcium chloride, black stamp pad ink, chewing gum, red aerosol paint, 10% ammonium hydroxide, 1% soap solution, turpentine, Urea 5%, diesel fuel and motor oil.
   9. Abrasive Wear of Tile when tested by BYK - Gardner Tester ASTM D 2486-00 with reciprocating linear motion of 37± cycles per minute over a 10" travel. The abrasive medium, a 40 grit Norton Metallite sand paper, to be fixed and leveled to a holder. The combined mass of the sled, weight and wood block is to be 3.2 lb. Average wear depth shall not exceed 0.060 after 1000 abrasion cycles when measured on the top surface of the dome representing the average of three measurement locations per sample.
   10. Resistance to Wear of Unglazed Ceramic Tile by Taber Abrasion per ASTM C501-84 (re approved 2002) shall not be less than 500.
   11. Fire Resistance of Tile when tested to ASTM E 84-05 flame spread shall be less than 15.
   12. Gardner Impact to Geometry "GE" of the standard when tested by ASTM D 5420-04 to have a mean failure energy expressed as a function of specimen thickness of not less than 550 in. Ibf/in. A failure is noted when a crack is visible on either surface or when any brittle splitting is observed on the bottom plaque in the specimen.
   13. Accelerated Weathering of Tile when tested by ASTM G 155-05a for 3000 hours shall exhibit the following result - AE <4.5, as well as no deterioration, fading or chalking of surface of tile color No 33538
   14. Accelerated Aging and Freeze Thaw Test of Tile and Adhesive System when tested to ASTM D 1037-99 shall show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles or other detrimental defects.

15. Salt and Spray Performance of Tile when tested to ASTM B 117-03 not to show any deterioration or other defects after 200 hours of exposure.
16. AASHTO HB-17 single wheel HS20-44 loading "Standard Specifications for Highways and Bridges". The Cast In Place Tile shall be mounted on a concrete platform with a Vi' airspace at the underside of the tile top plate then subjected to the specified maximum load of 10,400 Ibs., corresponding to an 8000 Ib individual wheel load and a 30% impact factor. The tile shall exhibit no visible damage at the maximum load of 10,400 Ibs.
17. Embedment flange spacing shall be no greater than 3.1" center to center spacing as illustrated on the product Cast In Place drawing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. During Cast In Place Detectable/Tactile Warning Surface Tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.

B. Prior to placement of the Cast In Place Detectable/Tactile Warning Surface Tile system, review manufacturer and contract drawings with the Contractor prior to the construction and refer any and all discrepancies to the Architect.

C. The specifications of the structural embedment flange system and related materials shall be in strict accordance with the contract documents and the guidelines set by their respective manufacturers.

D. The physical characteristics. of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 - 7 to permit solid placement of the Cast In Place Detectable/Tactile Warning Surface Tile system. An overly wet mix will cause the tile to float. Under these conditions, suitable weights such as 2 concrete blocks or sandbags (25 Ib) shall be placed on each tile.

E. The concrete pouring and finishing operations require typical mason's tools, however, a 4' long level with electronic slope readout, 25 lb. weights, and a large non-marring rubber mallet are specific to the installation of the Cast In Place Detectable/Tactile Warning Surface Tile system. A vibrating mechanism such as that manufactured by Vibco can be employed, if desired. The vibrating unit should be fixed to a soft base such as wood, at least 1 foot square.

F. The factory-installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.

G. When preparing to set the tile, it is important that no concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes in the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each embedment flange on the underside of the tile. This will lock the tile solidly into the cured concrete.

H. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, the electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. The Cast In Place Detectable/Tactile Warning Surface Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

I. In cold weather climates it is recommended that the Cast In Place Detectable/Tactile Warning Surface Tiles be set deeper such that the top of domes are level to the adjacent concrete on the top and sides of ramp and that the base of domes to allow water drainage. This installation will reduce the possibility of damage due to snow clearing operations.

J. Immediately after placement, the tile elevation is to be checked to adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. Ensure that the field surface of the tile is flush with the surrounding concrete and back of curb so that no ponding is possible on the tile at the back side of curb.

K. While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.

L. During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning or external forces placed on the tile that may rock the tile causing a void between the underside of tile and concrete.

M. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two suitable weights of 25 Ib each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.

N. Following the concrete curing stage, protective plastic wrap is to be removed from the tile surface by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft brass wire brush will clean the residue without damage to the tile surface.

O. To ensure that adjacent tiles are flush to each other during installation, individual tiles shall be bolted together using 1/4 inch or equivalent hardware. To ensure that concrete does not rise up between the tiles during installation, tape or caulking shall be placed on the underside of the bolted butt joint. Any protective plastic wrap which was peeled back to facilitate bolting or cutting, should be replaced and taped to ensure that the tile surface remains free of concrete during the installation process.

P. Tiles can be cut to custom sizes, or to make a radius, using a continuous rim diamond blade in a circular saw or mini-grinder. Use of a straightedge to guide the cut is advisable where appropriate.

Q. Any sound-amplifying plates on the underside of the tile, which are dislodged during handling or cutting, should be replaced and secured with construction adhesive. The air gap created between these plates and the bottom of the tile is important in preserving the sound on cane audible properties of the Armor-Tile system as required in various jurisdictions.

3.2 CLEANING, PROTECTING AND MAINTENANCE

A. Protect tiles against damage during construction period to comply with Tactile Tile manufacturer's specification.

B. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.

C. Clean Tactile Tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean Tactile Tile by method specified by Tactile Tile manufacturer.

D. Comply with manufacturer's maintenance manual for cleaning and maintaining tile surface and it is recommended to perform annual inspections for safety and tile integrity.

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 60 00 – PRODUCT 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.) 525 N. Great Southwest Parkway, Grand Prairie, Texas 76011 (phone 972-641-4911), 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 2500 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.

D. Traffic 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. 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:
American Fence Company
Wheatland Tube
Master Halco
SPS Stephens Pipe & Steel
Merchants Metals

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. Galvanized Steel: Size as indicated on the plans, vinyl-covered. 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 (11 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 31 19

DECORATIVE METAL FENCES & GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Ornamental welded steel fence systems.

1.02 RELATED SECTIONS

A. General Conditions, Supplementary Condition and Sections in Division 1

B. Section 31 00 00 - Earthwork.

1.03 REFERENCES

A. American Welding Society (AWS): AWS D1.1 - Structural Welding Code - Steel.

B. ASTM International (ASTM):
1. ASTM A36 – Carbon Steel
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
4. ASTM D822 – Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
5. ASTM D3363 – Test Method for Film Hardness by Pencil Test
6. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

C. Code of Federal Regulation (CFR): 28 CFR Part 36 - Americans With Disabilities Act - hereinafter referred to as ADA.

D. International Code Council (ICC): ICC-ES AC174 - Deck Board, Handrails and Fence Testing.

E. International Conference of Building Officials (ICBO): ICBO UBC - Uniform Building Code.

1.04 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Provide exterior systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
1. Temperature Change (Range): 120 degrees F (49 degrees C) ambient; 180 degrees F (82 degrees C) material surfaces.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.05 SUBMITTALS

A. General: Submit under provisions of Section 01 33 23 – SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

B. Product Data: Manufacturer's printed product information indicating material compliance and specified options are to be submitted prior to installation. Submit manufacturer's data sheets on each product to be used.

C. Shop Drawings: Layout of system components with dimensions, details, and finishes shall be submitted for approval and shall be approved prior to installation. Include plans, elevations, sections, details, and attachments to other work.

D. Design Data: Submit design data to verify compliance design loads specified in Performance Requirements Article. Design data shall be signed and sealed by the qualified professional engineer responsible for their preparation.

E. Samples:
1. Submit samples for initial color selection. Submit samples of each specified finish. Submit samples in form of manufacturer's color charts showing full range of colors and finishes available. Where finishes involve normal color variations, include samples showing the full, range of variations expected.
2. Submit samples for verification purposes. Samples shall be submitted prior to installation. Submit samples for the following:
3. For each type of exposed finish required.
4. Of each distinctly different linear railing member.

F. Certificates:
1. Mill certificates signed by manufacturers of steel products certifying that products furnished comply with requirements.
2. Welding certificates.

G. Qualification Data: For professional engineer.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified inspecting and testing agency, according ASTM E935.

I. Closeout Submittals: Operation and maintenance data.

1.06 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer Qualifications: Company engineering and fabrication of custom fencing and gate systems for a minimum of 15 years.
2. Installer Qualifications: Company experienced in manufacturer's products for a minimum of 5 years. The Contractor shall provide trained laborers with prior experience in the type of construction involved as well as experience installing the materials and techniques specified.
3. Qualified Professional Engineer: A professional engineer licensed in the state of the Project location and who is qualified to design the portion of the work described in this Section.

B. Regulatory Requirements: Completed installations shall meet ICBO UBC standards, applicable requirements of ADA Accessibility Guidelines along with any local amendments and/or modifications. Completed installations shall also conform to applicable state, regional, and local codes and regulations.

C. Source Limitations: Obtain each type of system through one source from a single manufacturer.

D. Modifications: Do not modify intended aesthetic effects as judged solely by the Architect, expect with the Architect's approval. If modifications are proposed, submit comprehensive explanatory data to the Architect for review.

E. Welding: Qualify procedures and personnel according to AWS D1.1.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with pertinent provision of section – Product Storage & Handling Requirements.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store components in a dry, sheltered location away from uncured concrete, masonry, mortar, and stucco; and a safe distance away from any sanding, blasting, welding and/or painting operations.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.08 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with fencing and gates by field measurements before fabrication and indicate measurements on shop drawings. Provide allowance for trimming and fitting at site.

1.09 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for fencing and gates. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to the Project Site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support systems temporarily by any means that do not satisfy structural performance requirements.

1.010 WARRANTY

A. Provide manufacturer's standard 10 year limited warranty, from the date of purchase, against defects in materials and workmanship including protection against cracking, peeling, blistering, and corrosion (rusting).

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:

B. Ameristar Fence Products, Inc. which is located at Tulsa, Oklahoma

C. Substitutions: Requests for substitutions will be considered in accordance with provisions of Section 01 66 00 - PRODUCT REQUIREMENTS.

2.02 MANUFACTURED UNITS

A. Ornamental Welded Steel Fence Systems:
   1. Product:
      a. Montage II Majestic as manufactured by Ameristar Fence Products, Inc. or
      b. Approved Equal
   2. Materials: per manufacturer’s recommendations.
   3. Components:
      a. Rails: per manufacturer’s recommendations
      b. Pickets: per manufacturer’s recommendations
      c. Posts: per manufacturer’s recommendations
      d. Fasteners: Nuts, bolts, sheet metal screws, and wood screws shall be stainless steel conforming to ASTM F 593.
      e. Fittings: Fabricated tees, elbows, splice connections, wall returns, wall ends and other similar components shall be of the same material, specification, and finish as fence panels.

f.. All fence and gate hardware, including hinges and latches shall be metal. No plastic allowed.

4. Fabrication:
   a. Fence panels shall be fabricated in standard length per manufacturer's recommendations.
   b. Welded connections shall comply with AWS standards for recommended practice in shop welding.
   c. Components shall be accurately cut and drilled to receive hardware, fasteners, and accessories.
5. Finish:
   a. Metal parts shall be assembled and finished individually prior to shipment.
   b. Galvanized steel fence components shall be cleaned with a non-petroleum solvent followed by the application of a sealing zinc phosphate coating.
   c. Immediately after sealing, a two-step powder finish coating shall be applied by the electrostatic spray process. This shall consist of a thermosetting carboxyl polyester resin top coat with a minimum dry film thickness of 60 microns to 70 microns.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
   1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.02 PREPARATION

A. Stake layout showing locations of gates and posts. Contact applicable authorities and take necessary precautions prior to beginning any excavation work.

B. All new installation shall be laid out by the contractor in accordance with the construction plans. Prior to fabrication, field verify required dimensions.

3.03 INSTALLATION

A. Install fences in accordance with manufacturer's written instructions. Installation shall conform to the specifications referenced elsewhere in this Section and as indicated on the Drawings. Fence posts shall be set in concrete footers having a minimum depth of 36" with a minimal diameter of 12". Fence posts shall be spaced in accordance with manufacturer's recommendation to accommodate installation of brackets as necessary. For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer with approved fasteners and techniques to ensure fences sections are parallel to grade.

B. Gate Installation: Install in accordance with manufacturer's printed instructions. Gate posts shall be spaced according to manufacturer's gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. The manufacturer's gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendation. Do not mount gate from wall of a structure. Provide gate post on both sides of a gate. For double drive gate installation, provide concrete center drop to foundation depth and drop rod retainers at center. Lubricate to ensure smooth operation and verify proper latch operation.

3.04 CLEANING

A. Remove cutting and drilling chips that are attached to the fencing, post, brackets, or additions to prevent corrosion.

B. Repair scratches and other installation-incurred damage. Repair areas per manufacturer's recommendation using a spray paint of the appropriate color that shall include a zinc additive, repaint and seal any scratches or holes drilled in the fencing, post, brackets, or additions to prevent rust from forming.

C. Clean up debris and unused material, and remove from site.

3.05 PROTECTION

A. Protect finishes from damage during construction period with temporary protective coverings approved by manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 32 31 32

COMPOSITE FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Composite fencing.

B. Related Sections:
1. Section 03 30 00 - Cast-in-place concrete.

1.2 QUALITY ASSURANCE

A. Provide composite fences as complete units controlled by a single source, including necessary erection accessories, fittings and fastenings.

1.3 WARRANTY

A. Provide 25-year limited warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide complete installation of Seclusions Composite fencing as manufactured by Trex Company, Inc. Refer to “Material Finish Schedule” for color.

B. Fasteners: Provide galvanized screws, brackets, and metal inserts of the sizes required.

C. Concrete: Provide a mix designed to produce concrete with a minimum 28-day compressive strength of 2,500 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not begin installation and erection before final grading is completed.

B. Installation of fence shall be by skilled fence erector and on lines and grades indicated.

C. Drill post footing holes in undisturbed or compacted soil. Bottom of posts shall be set not less than 30" in concrete base.

D. Center posts and align in holes 2" above bottom of excavation. Place concrete around posts and vibrate or tamp for consolidation. Extend concrete footings 2" above grade and trowel to a crown.

E. Securely attach composite rails and pickets with galvanized screws and brackets.

END OF SECTION

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SECTION 32 84 00

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 84 10 BOOSTER PUMP SYSTEM
   2. 32 92 13 HYDROMULCHING
   3. 32 92 23 SOD
   4. 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 SAMPLES AND TESTS

A. Contractor shall test all non-potable irrigation water before applying it to any sod, seed, trees, shrubs or other plant material. All irrigation water shall meet these standards:
   1. Sodium Absorption Ratio (SAR) shall be less than 3.0
   2. Electrical Conductivity (ECe) shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade.
   3. Boron shall be less than 2 parts per million
   4. Arsenic and Lead shall each be less than 0.1 parts per million
   5. pH shall be between 6.0 and 7.5
   6. Submit lab test results to Landscape Architect for review and possible adjustments to water.

1.08 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

A. 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.

B. 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.
C. Contractor shall be responsible for all costs during the maintenance period to include, but not be limited to: cost of water, electricity, fertilizer, replacement materials, equipment, transportation, and labor, etc.

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 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 8400 PLANTING IRRIGATION
   2. 32 8410 BOOSTER PUMP SYSTEM
   3. 32 9213 HYDROMULCHING
   4. 32 9300 TREES, SHRUBS, AND GROUNDCOVERS

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 TifTuf, Tif 419, Common Bermuda, St. Augustine, etc.
      b. Variety –Bermuda TifTuf, Tif 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)
   3. Submit results to Landscape Architect for adjustment to soil amendments and fertilizers.

C. Contractor shall test all non-potable irrigation water before applying it to any sod. All irrigation water shall meet these standards:
   1. Sodium Absorption Ratio (SAR) shall be less than 3.0
   2. Electrical Conductivity (ECe) shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade.
   3. Boron shall be less than 2 parts per million
   4. Arsenic and Lead shall each be less than 0.1 parts per million
   5. pH shall be between 6.0 and 7.5
   6. Submit lab test results to Landscape Architect for review and possible adjustments to water.

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

N. Water: Source furnished by the Contractor, cost and transport of water, as required, by the Contractor. Water to be as described in 1.07.C.

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. Contractor shall be responsible for all costs associated with establishment during the maintenance period to include, but not be limited to: cost of water, electricity, fertilizer, replacement materials, equipment, transportation, and labor, etc.

C. 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.

D. Contractor shall touch-up sod areas as required to achieve 100% coverage at no cost to Owner.

E. 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.

F. 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.

G. 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 provided in Section 1.9, GUARANTEE AND REPLACEMENT.

H. 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.

I. Turf areas are to be maintained so as to be 98% (minimum) weed-free. If live perennial or annual weeds exist within sod areas, remove them mechanically or spray them with a selective and 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 while being careful not to damage surrounding turfgrass. Maintain the site weed-free until final acceptance by the Landscape Architect, utilizing mechanical and chemical treatment.

J. 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)
   3. Submit results to Landscape Architect for adjustment to soil amendments and fertilizers.

C. Contractor shall test all non-potable irrigation water before applying it to any plant material. All irrigation water shall meet these standards:
   1. Sodium Absorption Ratio (SAR) shall be less than 3.0
   2. Electrical Conductivity (ECe) shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade.
   3. Boron shall be less than 2 parts per million
   4. Arsenic and Lead shall each be less than 0.1 parts per million
   5. pH shall be between 6 and 7.5
   6. Submit lab test results to Landscape Architect for review and possible adjustments to water.

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: limestone, heavy clays, and construction debris including: mortar, concrete, paint, paint thinner, chemicals, weeds, plastic, paper, steel, wire, mortar, masonry, ruction debris, and other substances that are harmful to plant growth. Remove the above items to these minimum depths:

1. Turf and Seed areas: 6” minimum
2. Planting beds: 18" minimum.

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 treatments.

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. Do not pile mulch around the stems of shrubs or the trunks of trees. 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. Contractor shall be responsible for all costs associated with establishment during the maintenance period to include, but not be limited to: cost of water, electricity, fertilizer, replacement materials, equipment, transportation, and labor, etc.

C. Plants shall be inspected at least once per week by the Contractor during the installation period and needed maintenance performed promptly.

D. 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.

E. Plants shall be pruned, and mulch shall be replaced as required.

F. Tree stakes and guys shall be adjusted or replaced as required. Repair eroded plant saucers.

G. Always maintain all plant beds and tree saucers weed-free. Shrub beds and tree saucers areas are to be maintained so as to be weed-free. If live perennial or annual weeds exist in mulched shrub beds or tree saucers, remove them mechanically or spray them with a 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 while being careful not to damage other plant material. Maintain the site weed-free until final acceptance by the Landscape Architect, utilizing mechanical and chemical treatment.

H. 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.

I. 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.

J. Remove and replace, at no cost to Owner, dead and unacceptable plants as their condition becomes apparent.

END OF SECTION

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/Fireline Pipe, 4” through 12”: AWWA C900, Class 200, DR-14.

2.02 FIRE HYDRANTS

A. Manufacturer 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 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 Item 501.17 per NCTCOG.

2.02 Structures

A. Materials for the construction of manholes shall be as specified in Division 7, “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 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. 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 7, “Concrete Structures” of NCTCOG and the City 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. <u>If abrupt grade changes are present, grade adjustments will be required.</u>

END OF SECTION

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 and box 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 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 700, "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 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. Catch basins and headwalls outside of pavement areas shall be either 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