Project Manual:

Homefull Housing, Food, and Jobs

Gettysburg Avenue Campus

807 S. Gettysburg Ave.
Dayton, Ohio 45417

OWNER	Homefull 2621 Dryden Road, Suite 302 Dayton, Ohio 45439
DATE	September 9, 2022

VOLUME 2 (Division 21 – 32)

ARCHITECT	LWC Incorporated 434 East First Street Dayton, Ohio 45402 Phone: (937) 223-6500	
CIVIL ENGINEER	Burkhardt Engineering 28 N. Cherry Street Germantown, Ohio 45327 Phone: (937) 388-0060	
STRUCTURAL ENGINEER	Shell & Meyer 2202 S. Patterson Blvd. Dayton, Ohio 45409 Phone: (937) 298-4631	
MECH/ ELEC ENGINEER	CMTA 222 E. 14th Street, 4th Floor Cincinnati, Ohio 45202 Phone: (513)429-4404	
TECHNOLOGY	Copp Systems 123 South Keowee Street Dayton, OH 45402 Phone: (937) 228-4188	
FOOD SERVICE EQUIPMENT	Vondran and Associates 3125 Sterling Ridge Cove Ft. Wayne, IN 46825 Phone: (260) 496-9992	VONDRAN & ASSOCIATES FOOD SERVICE FACILITY DESIGN

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PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 ALTERNATES

A. Within the forms of their bid proposals, contractors shall state the total (labor and material) amount, (with markups), to be added to or deducted from the base bid amount for each of the alternates indicated herein or within the Bid Form or Instructions to Bidders, that the Owner may or may not decide to accept.

1.3 UNIT PRICES

A. Within the forms of their bid proposals, contractors shall state the total labor and material unit price (with markups) for each of the unit scope-of-work items that might be added or deducted on a unit-by-unit basis during the construction period of the project, that takes place before final inspection or date of acceptance review. See Bid Form or Instructions to Bidders as relates to these unit cost items.

1. Indicate all unit costs, including controls, wiring and interlocks, as outlined and referenced within the bid form or Instruction to Bidders.

1.4 GUARANTEE

A. In entering into a contract covering this work, the Contractor accepts the Specifications and Drawings and guarantees that the work will be carried out in accordance with the requirements of the Specifications and Drawings or such authorized modifications as may be made in the Contract Documents. Contractor further guarantees that the workmanship and material will be first class and that only experienced workers, familiar with each particular class of work, will be employed. Contractor further guarantees to replace and make good at his own expense any defects due to faulty workmanship or material which may develop within one (1) year after final payment and acceptance by the Owner, upon receipt of written notification of defect from the Owner.

1.5 QUALITY ASSURANCE

A. Regulations and Standards: All equipment, apparatus, and systems are to be fabricated and installed in complete accordance with fire and insurance rules and regulations, the Life Safety Code, and the latest edition or revision of the following applicable regulations, standards, and codes:

1.	AIA	American Institute of Architects
2.	ASME	American Society of Mechanical Engineers
3.	ASTM	American Society for Testing and Materials
4.	NFPA	National Fire Protection Association
5.	NEC	National Electric Code
6.	OSHA	Occupational Safety and Health Administration
7.	UL	Underwriter's Laboratories, Inc.
8.	MCAA	Mechanical Contractors Association of America, Inc.
9.	ANSI	American National Standard Institute
10.	MSSV	Manufacturer's Standardization Society of the Valve and Fitting Industry
11.	AWWA	American Water Works Association
12.	NACE	National Association of Corrosion Engineers

13. State and Local Fire Marshal
14. Owner's Fire Insurance Agency requirements
15. Division 01 Sections “Regulatory Requirements: and “Reference Standards” of the Project Specifications
16. References on the Drawings or in the Specifications to "code" or "building code" not otherwise identified shall mean the specific codes applicable to this Project location, together with all additions, amendments, changes, and interpretations adopted by code authorities having jurisdiction over this Project.
17. The applicable edition of all codes shall be that adopted at the time of issuance of permits by the authorities having jurisdiction, and shall include all modifications and additions adopted by that jurisdiction.
18. Give all required notices so as to comply with, and meet, all inspections required by Federal, State, and Local authorities.
19. It is not the intent herewith to modify, reduce, or change any rules, standards, regulations, or requirements that are applicable under local, state and federal codes, ordinances, or regulations of the various authorities having jurisdiction. Where the standards differ among the various authorities, the most restrictive shall apply. Where the requirements shown on the Drawings or called for in the Specifications exceed code requirements, these Drawings and Specifications shall take precedence. Where the requirements within the specifications of this division of work and the Drawings conflict with the referenced Divisions, Sections, and other documents, the documents having the most restrictive and the higher cost requirements shall apply.

1.6 JOB CONDITIONS AND COORDINATION

A. Local Conditions

1. Each Trade Contractor is to inform themself of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work to be done.
2. Contractors shall coordinate and review indicated utility data with the local utility companies.

B. Present Job Site Inspection

1. Each contractor shall schedule through the Owner a visit to the present site proposed for the work before presenting a Bid and shall make a careful inspection of the existing conditions.
2. During the site visit, each Trade Contractor is to investigate for any existing conditions and responsibilities which are not clearly defined by the Drawings and Specifications. If any such conditions exist, he/she shall bring them to the attention of the A/E in writing. The A/E will then make the required written clarification. The absence of questions before the opening of bids shall indicate a clear understanding of the scope of work and the Contractor's responsibility.

C. Concrete Housekeeping Pads and Supporting Foundations

1. Unless otherwise specified or noted on the Drawings, the Contractor or Subcontractor whose equipment the concrete pad or foundation services is to locate, size, and pay the Concrete Contractor to provide concrete pads and foundations as indicated on the Drawings for all of their equipment.
2. Concrete pads as may be indicated are based upon the design and layout-based manufacturer and model of equipment and devices as specified or as scheduled or noted on the Drawings.
3. The individual Trade Contractor furnishing the equipment or devices is to verify and coordinate all concrete pad sizes so as to have same of proper size to serve the equipment or device supplied and verify the position of all anchor bolts.
4. Any additional cost for larger than indicated pad or foundation sizes to fit the approved manufacturer and model of the equipment or devices is to be borne by the Trade Contractor who supplies such equipment or devices.

D. Permits and Fees: This Contractor is to obtain all permits and pay all fees required for the work under Divisions 21 of the Work.

E. Royalties and Patents

1. The Trade Contractor is to pay all royalties and license fees. He/She shall defend, indemnify, and hold the Owner and A/E harmless from any and all suits, demands or claims for infringement of any patent rights.
2. The review by A/E or Owner of any method of construction, invention, appliance, process, article, device or material of any kind is to be for adequacy of work, and is not to be construed as an approval of the use thereof by the Contractor in violation of any patent or other rights of any third person.

F. Wiring and Conduit Requirements: In general, most wiring and conduit requirements are addressed, either upon the Drawings as a part of a packaged equipment assembly specifications, or within Divisions 26, 27 and 28 of the Specifications. However, should an equipment component, panel, or system device need additional wiring and conduit so as to be complete, approved and fully operational, the Contractor who supplied the equipment component, panel or system device shall be responsible for the required wiring and conduit as well as circuit disconnect and protection for same when it is not otherwise covered by the Project Drawings and Specifications.

G. Coordination: Coordinate the exact location of this work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.

1.7 SPECIFICATIONS AND DRAWINGS

A. These specifications and Drawings are intended to describe and provide for a complete and finished project. They are intended to be complementary. All items of work called for by either shall be as binding as if called for by both. The work described shall be complete in every detail, notwithstanding the fact that every item necessarily involved is not particularly mentioned or shown.
1. If the Bidder, Supplier or Contractor sees anything to question, it must be brought to the attention of the A/E immediately.

B. Minor Deviations: The Drawings accompanying these Specifications indicate the general design and arrangement of equipment, apparatus, fixtures, accessories and piping necessary to complete the installation of the system. The exact location or arrangement of the apparatus and equipment, unless otherwise dimensioned, is subject to minor changes necessitated by field conditions and shall be required without additional cost to the Owner. Measurements shall be verified through actual observation at the construction site. Each Trade Contractor shall be responsible for fitting all of his work into place in a satisfactory and workmanlike manner, to the approval of the A/E and Owner.

C. Provide all labor and materials necessary for the completion of the work described. Referenced codes and industry standards and methods shall apply when no other specifics are indicated. Bring questions relating to this paragraph to the attention of the A/E for resolution prior to the receipt of Bids.

D. All Work indicated on Drawings, diagrams, or details in part only are to continue throughout unless distinctly marked otherwise. The same applies to other parts of the project where merely a typical reference plan, diagram, or section of the drawing is complete. The balance is intended to be the same as the typical plan, section, or diagram as shown and is to be figured accordingly.

E. The specifications are divided into trades and divisions only for the distinct purpose of facilitating the work. However, the Trade Contractor will become responsible for furnishing all labor and materials

necessary to complete the project as contemplated by the Drawings and Specifications. Any item mentioned under any heading of the Specifications must be supplied even though it is not called for again under the heading for the respective work.

F. Should discrepancies occur within the Contract Documents, the more stringent and more costly approach shall apply for bidding purposes. The Contractor is to notify the A/E of discrepancies for clarification. Clarifications issued after the Contract is awarded shall be incorporated by the Contractor at no additional costs and shall be reviewed by the A/E to determine if a reduction in cost is justified.

1.8 TRADE CONTRACTORS, SUBCONTRACTORS AND SUPPLIERS

A. The Trade Contractor is any person or organization who contracts to perform work for the Project. Wherever the word "Contractor" is used on the Drawings or in the Specifications, it shall be construed to mean the Trade Contractor applicable to the Title Division of these specifications.

B. A Sub-Contractor is a person or organization who has a direct contract with a Trade Contractor to perform any of the Work at the site and includes all who furnish material worked to a special design in accordance with the Drawings and Specifications, but excludes suppliers or persons furnishing material not specially designed. Wherever the term "Sub-Contractor" is encountered in the Contract Documents, it shall mean the Sub-Contractor and/or his Sub-Sub-Contractors and/or his Material Suppliers.

C. A Sub-Sub-Contractor is a person or organization who has a direct or indirect contract with a Sub-Contractor to perform any of the Work at the project site or for the subject project.

D. A Material Supplier is a person or organization who has a direct contract with a Trade Contractor to furnish material not specially designed.

E. It shall be the responsibility of each Trade Contractor to be fully familiar with various local trade jurisdictional requirements and to engage the services of any other Sub-Contractors as may be required within the various trades to complete all of the work as indicated upon the Drawings and within the Specifications under his respective division or section. Only Trade Sub-Contractors with established knowledge and skills of their specific trade shall be used, so that all work is performed in a complete, finished, and professional manner.

F. Whenever any provisions of the Specifications conflict with any agreements or regulations in force among members of any Trade Associations, Unions, or Councils which regulate or distinguish what work shall or shall not be included in the work of any particular trade, the Trade Contractor shall make all necessary efforts to reconcile any such conflict without delay, damage or cost to the Owner.

G. If the progress of the work is affected by any undue delay in furnishing or installing any items of material or equipment required under the contract because of a conflict involving any such agreement or regulation, the A/E may require that other material or equipment of equal kind and quality be provided at no additional cost to the Owner.

H. Any Trade Contractor, subcontractor, or material supplier not normally employing union labor shall make all provisions necessary to avoid any resulting disputes with labor unions and shall be responsible for any delays, damages or extra cost caused by employment of such non-union labor, except as otherwise governable by state or federal rules and regulations.

I. Each Trade Contractor shall pay for all applicable Federal, State and local taxes on all materials, labor or services furnished by him/her, and all taxes arising out of his operations under the Contract Documents which may be imposed upon or collectable from the Owner or become a lien against his property. Such taxes shall include, but not be limited to, Occupational, Sales, Use, Excise, Social Security and Unemployment Taxes, customs duties, and all income taxes and other taxes now in force or enacted prior to final acceptance of the work. The Trade Contractor shall assume all liability for the payment of and

shall pay any unemployment benefits payable under any Federal or State law to individuals employed by him/her during the progress of the work covered by the Contract.

J. It is the responsibility of each Trade Contractor to coordinate the various related equipment requirements between his subcontractors, suppliers, and other trade contractors, and to also follow the approved manufacturer's installation instructions.

1.9 OPERATIONAL AND MAINTENANCE INSTRUCTIONS

A. All operational and maintenance instructions that are provided to various Owner-selected members of the facility engineering and/or maintenance staff are, at the same time presented, to be fully videotaped by the Contractor so that all such sessions can be later reviewed by the Owner's staff on a retraining basis as needed. All such videotapes are to become the property of the Owner at the end of each applicable training period, with one copy of each also being supplied to the A/E for the A/E project files.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/PRODUCTS/SUBMITTALS

A. Under the Base Bid, no other manufacturers except those indicated on the Drawings or those listed within the Sections of this Division, that are, in turn, able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable. In addition to specific required "Alternates," proposed substitutions that may or may not be acceptable to the Owner may be submitted by the Contractor only at the time of initial base bid submittal.

B. Although design-based models of various manufacturers may be indicated within the various schedules, it is the responsibility of the various equipment manufacturers to verify the model selections so that all items of equipment comply with the minimum standards of performance that are indicated within the schedules, as well as the requirements within various sections of the specifications under which the equipment is also specified.

C. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

D. Shop Drawing are to be submitted on each item of specified or scheduled equipment, valves, specialties, controls, and related accessories.

2.2 ACCESS DOORS AND PANELS

A. Unless otherwise indicated, each Trade Contractor is to locate and furnish all access doors required for non-accessible surfaces (such as ceilings, walls, chases, and similar locations), so that all valves and similar items are easily accessible for operation, inspection and maintenance. Access doors for ceiling, walls, chases, etc. are to be installed by the General Contractor. The Trade Contractor is to bear the costs of the installation of the access doors.

2.3 SLEEVES

A. Each Contractor is to provide properly sized, secured and firestopped sleeves for all of their piping systems at all penetrations of walls, foundations, partitions, floors and roofs throughout the entire facility.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all materials, labor, equipment, and services necessary for a complete and operable installation as specified and shown on the Drawings. The word "Provide" shall mean "Furnish and install."

B. Provide new material and equipment in strict accordance with these Specifications and the Project Drawings.

C. At all times, take such precautions as are necessary to protect materials from damage. Close all pipe openings to prevent obstructions and contamination.

3.2 CUTTING AND PATCHING IN BUILDINGS

A. Each Contractor is responsible for all costs associated with the necessary cutting and patching as required for the installation of his work, unless otherwise indicated.

B. Patching is to be performed by the trade proper for each material to be patched. Patching shall leave premises and finishes in a complete and neat condition comparable to the original. Painting of patched surfaces to be by the painting sub-contractor of the General Contractor, unless otherwise specifically indicated or the plumbing/fire protection contractor is the prime contractor for the project. Maintain the fire integrity of all walls, floors, ceilings, and partitions.

3.3 PROTECTION

A. Protect equipment and trim against damage and injury due to building materials, acid, tools, equipment and any causes incidental to construction. Cover the finished surface of each piece of equipment with building paper or similar protection. Replace all equipment damaged by any cause and any trim with marred or scratched finish at no cost to the Owner, upon receipt of written notification from the A/E.

B. Where materials to be installed are being stored at or near the project during construction, arrange such materials so as to minimize the possibility of contamination, corrosion and damage. Keep ends of pipe, equipment, and specialties properly closed during construction and installation to avoid the possibility of miscellaneous materials being placed in the openings.

3.4 PAINTING

A. See Division 09 Sections.

3.5 ADJUST AND CLEAN

A. Inspect all equipment and put in satisfactory working order.

1. Clean all exposed and concealed items.
2. Clean specialties such as floor control valve assemblies, and all equipment surfaces such as pumps, motors, alarm valves, etc.
3. Clean all covers.
4. Clean exposed piping.
5. Adjust pumps for proper flow rates.

3.6 OPERATIONAL TEST

A. Upon completion of and prior to acceptance of the installation, the Contractor shall subject the fire protection system to operating tests in accordance with NFPA.

END OF SECTION 210501

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE PROTECTION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 21 Sections “Vibration Controls for Fire Suppression Piping and Equipment” and “Seismic Restraint” for additional requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:

1. Pipe hanger and supports.
2. Pipe and equipment anchors.
3. Pipe sleeves.

B. All equipment and piping shall be supported and seismically braced as noted in Division 21 Section “Seismic Restraint”.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. NPFA

D. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA’s engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.4 SUBMITTALS

A. Shop Drawings

1. Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members.
2. Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Operating and maintenance data.
2. Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers: Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Concrete Anchors: Phillips, Hilti.

C. Pipe and Equipment Anchors

1. Shop-fabricated.
2. Field-fabricated.

D. Sleeves

1. Shamrock Industries, "Crete-sleeve" plastic hole forms.
2. Proset Systems Inc., "Proset" fire-safe pipe penetrations.
3. Shop for field fabricated.

E. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc.

2.2 PIPE HANGERS

A. General

1. Materials, Design and Manufacture: MSS SP-58.
2. Fabrication and Installation: MSS SP-89.
3. Selection and Application: MSS SP-69.
4. Hangers Used Directly on Copper Pipe: Copper or cadmium-plated.
5. All Other Hangers and Channels, Angles, and Supporting Steel: Cadmium-plated or galvanized.
6. All Hanger Rods of Continuous Thread Type: Electrogalvanize or cadmium plate after threads are cut.
7. Galvanize all structural steel, angles, rods, channels, and hardware that are not provided with a rustproof finish.
8. Screw Threads on Hangers and Fittings: Conform to Class 2A and 2B of ANSI B1.1.

B. Pipe Hangers for Bare Pipe

1. Bare Pipe:

MSS	B-Line	ANVIL
1	B3100/02 C	260
3	B3144/46	295
4	B3142	216

C. Pipe Hangers in Other Situations: See MSS-SP-69.

D. Hanging Rollers, Cast Iron

1. MSS Type 41.
2. B-Line B3114.
3. Anvil 171.

E. Supporting Roller, Cast Iron

1. MSS Type 44, 45, or 46.
2. B-Line B3117SL, B3117, B3118SL or B3119.
3. Anvil 271, 277, or 274.

F. Concrete Inserts

1. Continuous Slot Inserts
   a. Anvil Power Struct PS349.
   b. B-Line Figure B32I.
2. Individual Inserts
   a. Anvil Figure 282, or 281.
   b. Do not exceed manufacturer's recommended load on any insert.

G. Beam Clamps

1. B-Line Figure B3054 or B3055.
2. Anvil Figure 133, 218, 228, 292.

H. Attachment to “Z” Type Purlin

1. PHD Figure 290.
2. Michigan No. 315.

I. Attachment to Wood Structure

1. Provide angle clips and lag screws or side beam connectors: PHD figure 920 or 905.
2. Strap-type hangers not acceptable.

2.3 PIPE SLEEVES AND SEALANTS

A. Sleeves - General

1. Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping.
2. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:

1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
   1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.

F. Sleeve Sizes

   1. Length: Ends flush with finished surfaces.
   2. Diameter
      a. Minimum 3 inch.
      b. Minimum 1 inch larger than pipe and pipe insulation.
      c. In concrete, 1-1/2 inch larger than pipe.
      d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

G. Sealants: Seal annular space around piping.

   1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity.
      a. Provide proper material for each typical application as described by manufacturer.
   2. Acceptable Manufacturers
      a. Base
         1) Dow Corning "Fire Stop".
         2) Nelson "Flameseal".
         3) 3M "Fire Barrier".
         4) Pipe Shields Inc., Model WFB, DFB, or QDFB Series.
         5) Proset Systems.
   3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
   4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations

   1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
   2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
   3. Do not attach hangers to steel roof deck.
   4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E.
   5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction. At first elbow of equipment run out piping risers and horizontal piping within ten (10) feet of all circulating basemounted pumps having four (4) inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. Provide a hanger within one (1) foot or less of each horizontal elbow and valves that are above three (3) inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than six (6) feet, provide only one (1) hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

B. For fire protection piping, space according to NFPA Section 13.

C. For piping of other materials, space hangers according to manufacturer's recommendations.

D. Pipe Hanger Loading

1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

E. Trapeze Hangers

1. Suspend trapeze hangers from concrete inserts of approved structural clips.
2. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

F. Vertical Pipe Supports

1. Support all vertical pipe runs in pipe chases at base of riser.
2. Support pipes for lateral movement with clamps or brackets.

G. Concrete Inserts

1. Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required.
2. Provide concrete inserts in time for installation in concrete.

3.3 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors

1. Provide as indicated and required to permit complete installation of system.
2. Do not anchor piping to plaster or gypsum wallboard partition walls.
3. Provide anchoring devices at locations indicated.
4. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.4 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts.

1. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.5 MISCELLANEOUS STEEL

A. Piping Contractor (or Fire Protection Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel. Repair galvanized steel at field cuts and connections.

3.6 SEISMIC RESTRAINTS

A. Do not mix seismic bracing designs within a new system design.

B. SMACNA shall be considered applicable for seismic design force application. Seismic force applications shall be engineered by the Contractor and submitted for approval prior to installation.

C. Provide additional bracing/stiffeners on hanger rods as recommended by SMACNA to prevent hanger bending due to vertical seismic forces.

END OF SECTION 210529

SECTION 210548 - VIBRATION CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 21 Sections “Hangers and Supports for Fire Suppression Piping and Equipment” and “Seismic Restraint” for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems

1. Vibration isolators and hangers.
2. Resilient penetration sleeve/seal and lateral guides.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

C. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

D. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

E. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

B. Shop Drawings

1. All equipment items specified.
2. Spring Isolators
   a. Spring diameter.
   b. Deflection.

c. Compressed spring height.
d. Solid spring height.
e. Point location of each isolator.
f. Load at each point.
g. Field static deflection.
h. Horizontal loading and bolt requirements.
i. Indicate all bases and rail clearances.

3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
4. Special details necessary to convey complete understanding of the work to be performed.

C. Product Data

1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:

a. The equipment identification mark.
b. The isolator type.
c. The actual load.
d. The static deflection expected under the actual load.
e. Specified minimum static deflection.
f. The additional deflection to solid under actual load.
g. The ratio of spring height under actual load to spring diameter.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Closeout Information

1. Operating and maintenance data.
2. Guarantees.

PART 2 -

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound and Vibration Control Devices

1. Amber/Booth Co.
2. Korfund Dynamics Corp.
3. Mason Industries, Inc.
4. Peabody Noise Control Inc.
5. Vibration Mountings & Controls, Inc.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.

1. Acoustical sealant D.A.P.

2. BR-96 Pecora.
3. Acoustical sealant Tremco.
4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.

1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, welded concrete pouring forms and flexible pipe connectors from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:

1. All steel parts to be hot-dip galvanized.
2. All bolts to be cadmium-plated.
3. All springs to be cadmium-plated and neoprene-coated.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators

1. Type 1 Isolators: Double-deflection neoprene mountings.

a. Minimum static deflection: 0.35 inch.
b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
c. Friction pads both top and bottom to eliminate the need for bolting.
d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.
e. Mason Industries, Type ND; or Vibration Mountings, Type RD.

2. Type 2 Isolators: Spring-type.

a. Free-standing and laterally stable, without any housings, snubbers, or guides.
b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.
c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
f. Mason Industries, Type SLF; or Vibration Mountings and Controls, Type II, Series A.

3. Type 3 Isolators: Spring-type with vertical limit stop.

a. Equal to Type 2 isolator, except that mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.
b. Installed and operating heights to be the same.
c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.
d. Limit stops to be out of contact during normal operations.
e. Mason Industries, Type SLR; or Vibration Mountings and Controls, Type AWR.

4. Type 4 Isolators: Neoprene wafer pads.

    a. Durometer or hardness to suite application.
    b. Square waffle pattern on 1/2-inch centers.
    c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
    d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
    e. Provide type "W" adhesive, both sides, for all non-bolted applications.
    f. Mason Industries, Type "W", "WMW", "WML", or "WM"; or Vibration Mountings, Type VM.

B. Vibration Hangers

1. Type 5 Isolators: Steel spring-type hanger.

    a. Steel spring and 0.3 inch deflection neoprene element in series.
    b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
    c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
    d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
    e. Mason Industries, Type 30N; or Vibration Mountings, Type RSH.

2. Type 6 Isolators: Precompressed steel spring-type hanger.

    a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.
    b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
    c. Mason Industries, Type PC30N; or Vibration Mountings, Type RSHP.

3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.

    a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
    b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
    c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.
    d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
    e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.
    f. Mason Industries, Type W30; and Vibration Mountings, Type SHP.

4. Type 8 Isolators: Double-deflection neoprene-type hanger.

    a. Minimum static deflection: 0.40 inch
    b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
    c. Provide hanger for direct attachment to flat iron duct straps.
    d. Mason Industries, Type WHD; or Vibration Mountings and Controls, Type RHD.

2.4 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4 inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.5 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising pipes.

B. Resilient lateral guides shall be one of the following products:

1. Mason Industries, Type ADA.
2. Peabody Noise Control, Type RGN.
3. Vibration Mounting & Controls, Type MDPA.
4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

PART 3 - EXECUTION

3.1 APPLICATION

A. General

1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.

    a. Minimum static deflections may be revised subject to prior approval.
    b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.

        1) Provide revised vibration control equipment to match revised or substituted equipment.
3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.

    a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.

b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.
h. No pipes or equipment are to be supported from other pipes or equipment.
i. Resiliently isolated pipes are not to contact the building construction or other equipment.
j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

B. Pipes
1. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral supports.
2. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
3. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently mounted.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.

1. Air compressors, 3 hp or less.
2. Minimum static deflections, 0.35 inch.

B. Use Type 2 isolators for equipment mounted on floors other than grade-supported floor slabs.

1. All pumps, 30 hp and larger.
2. Minimum static deflections, 1.5 inch.

C. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.

1. Air compressors.
2. Minimum static deflections, 0.3 inch.

3.3 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be Type 8 isolators.

B. Horizontal runs in all other locations throughout the building shall be isolated by Type 7 isolators.

C. Floor supported piping shall rest on Type 3 isolators.

D. All Type 7 isolators, or the first three Type 8 mounts, as noted above, will have same static deflection as specified for the mountings under the connected equipment.

E. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and including 3 inch; 1.5 inch deflection for pipe sizes up to and including 6 inch; and 2.5 inch deflection thereafter.

F. All other hangers and mounts will have a minimum steel spring deflection of 0.75 inch.

G. Locate hanger as close to overhead supports as is practical.

END OF SECTION 210548

SECTION 210553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:

1. Piping identification.
2. Valve identification.
3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

PART 2 - PRODUCTS

2.1 PIPE MARKERS

A. Conform to ANSI A13.1.

1. Pressure-sensitive vinyl (self-sticking) material.
2. Mechanically Fastened Type: Snap-on or strap-on.
   a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
3. Provide with direction of flow arrows.
4. Size of Letters Legend

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

2.2 VALVE TAGS

A. Brass or Anodized Aluminum Type

1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:

a. Service: 1/4 inch stamped black filled letters.
b. Valve numbers: 1/2 inch stamped black filled letters.

2. Aluminum: 2-inch diameter, 0.032 inch thick, with following lettering:

a. Service: 1/4 inch engraved letters.
b. Valve numbers: 1/2 inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.3 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.

1. Two 3/8-inch mounting holes.
2. Lettering size: Minimum 1/2-inch high.
3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.4 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

2.5 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers

1. Craftmark Identification Systems.
2. W. H. Brady Co.
3. EMED Company, Inc.
4. Kolbi Industries, Inc.
5. 3M Co.
6. Seton Name Plate Corp.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. Designate all equipment and valves by distinguishing numbers and letters on charts and/or diagrams.

1. Tag and locate following equipment items:

a. Valves.
b. All items indicated on drawing equipment schedules.

B. Install tags on all devices with numbers and letters corresponding to charts.

C. Fasten tags securely to devices with tag fasteners in manner for easy reading.

D. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, and control panels.

1. Secure nameplates with self-tapping screws, or nuts and bolts.

E. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

F. Furnish 4 charts including device number, location (room number, department) and purpose.

1. Mount 1 chart in frame and secure on wall in location directed by Owner.
2. Include remaining 3 sets in "Operation and Maintenance Manuals."

G. Provide all devices located above ceilings with additional identification.

1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
2. Coordinate with Owner on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Locate pipe markers as follows:

1. Next to each valve and fitting, except on equipment.
2. At each branch or riser take-off.
3. At each passage through walls, floors, and ceilings.
4. At each pipe passage to underground.
5. On all horizontal pipe runs every 20 feet, at least once in each room and each story traversed by piping system.
6. Identify piping contents, flow direction.

B. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 SERVICE ABBREVIATIONS

A. General

1. S Sprinklers
2. F Fire Protection

END OF SECTION 210553

SECTION 211313 - FIRE PROTECTION SYSTEMS – WET-PIPE

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Fire protection systems include:

1. Sprinkler system.
2. Alarm and signal devices.

1.3 QUALITY ASSURANCE

A. Design Criteria

1. Provide complete fire protection system as indicated and as required by local authorities.
2. Where there is conflict between local authority requirements or other agencies' standard requirements and these Drawings and specifications, requirements of local authorities or other agencies shall govern.
3. Design and install entire system in accordance with indicated codes, standards and regulations.
4. Contractor shall hydraulically calculate sprinkler system in accordance with NFPA 13, based on hazard encountered. Hydraulic calculations shall be based on flow test and a safety (reserve) factor of 5 psig or 10% of system, whichever is greater.
5. Do not downsize piping indicated to serve future areas.
6. Drawings are diagrammatic only to indicate rooms/areas of sprinkler protection and piping clearances when appropriate.
7. Submit proposed layout and flow calculations for local fire authority's approval prior to shop drawing submittal.
8. Coordinate head locations with ceiling layouts.
9. At each floor provide a floor control valve assembly.
10. Each floor control valve assembly is to include supervised control valve, water flow switch, inspection test valves, site glass and drain.
11. Limit the velocity of the water in the sprinkler system piping to 20 feet per second.

B. Water Supply Requirements

1. Fire flow to meet local fire department and State requirements.
2. Fire protection contractor shall pay and arrange for certified fire flow test to be performed near the point of connection as required. Deliver three copies of certified flow test to the A/E and one to Owner's insurance company.

C. Hazard Class

1. Refer to Contract Drawings for sprinkler protection requirements and hazard classification.
2. Indicate classification of all sprinkled spaces on shop drawings.

D. System Standards

1. NFPA 13, Sprinkler Systems.
2. NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances.
3. State Inspection Agency (Building Code Dept.).
4. Local Inspection Agency (Building Code Dept.).
5. State Fire Marshal's requirements.
6. Local Fire Marshal's requirements.
7. State Insurance Services Office requirements.
8. State Fire Code.
9. International Fire Code.
10. Factory Mutual requirements.
11. Owner's insurance company or loss prevention division.

E. Installer's Qualifications

1. The systems are to be designed and installed by a State-certified firm regularly engaged in the design and installation of automatic fire protection systems in accordance with the requirements of the National Fire Protection Association and the State, and by the authorized Insurance and Reviewing Agents of the Owner. Evidence to support the above requirements is to be provided, and any proposed installer who cannot show suitable experience will be rejected.
2. The term qualified means experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this Project), familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the A/E and Owner.

1.4 SUBMITTALS (See Division 01)

A. Shop Drawings: Complete layout of fire protection system approved by all agencies having jurisdiction.

1. Shop Drawings of sprinkler systems are to include detail piping plans, sections, control valves, fire department connections, sprinkler heads, and other equipment used.
2. Site plans indicating underground supply connections, fire department connections, valves, etc.
3. Hydraulic calculations.

B. Product Data

1. Submit product data for all components, equipment, etc. specified in this Section.
2. Catalog cuts.
3. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Close-Out Information

1. Operating and maintenance data.
2. Owner instruction report.
3. Test Reports: Certification that all tests as indicated in paragraph "Field Quality Control" have been successfully completed and approved by all authorities having jurisdiction.
4. Guarantees/Warranties.

1.5 JOB CONDITIONS

A. Arrange and pay for all permits, fees and inspections required.

B. Fire sprinkler contractor is responsible for defining all required electrical connections to the Fire Alarm Panel with the electrical contractor. Electrical contractor will perform electrical installation of conduit and wire.

C. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of piping as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

D. All applicable switches shall be provided by this Contractor. In addition, it shall be the responsibility of this Contractor to review the scope of work and extent of related items that are presently included to be wired by the Electrical Contractor within the electrical part of the specification and drawing documents.

PART 2 - PRODUCTS

2.1 PIPE, FITTINGS, AND HANGERS

A. Fire Sprinkler Piping Above Ground

1. Black steel, Schedule 40 (1 inch thru 2-1/2 inches) and Schedule 10 (3 inches thru 8 inches), with threaded or mechanical joints, ductile iron couplings, and ductile iron grooved fittings.
2. Threaded Fittings: Cast iron.
3. Mechanical Joint Fittings: Black steel, rolled grooved by Victaulic or Grinnel.
4. Grooved mechanical couplings shall consist of two ASTM A536 ductile iron housings, pressure-responsive, synthetic rubber gasket, and plated steel bolts and nuts.

    a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13.

        1) 1-1/4-inch through 8-inch: "Installation Ready" stab-on-design, for direct "stab" installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock EZ Style 009H (1-1/4 inch to 4 inch) and Victaulic Style 107H QuickVic (2 inch to 8 inch).
        2) 10-inch and larger: Victaulic Style 07 Zero-Flex® standard rigid coupling.

    b. Flexible Type: Use in seismic areas where required by NFPA 13.

        a) 2 inch through 8 inch: "Installation Ready" stab-on design, for direct "stab" installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic.
        b) 10 inch and larger: Victaulic Style 75 or 77 standard flexible couplings.

B. Fire Sprinkler Piping Below Ground: Ductile cast iron, lined and coated, with mechanical joint fittings.

C. Pipe Hangers

1. All purpose type, UL-listed and FM-approved.
2. Comply with Division 21 Section "Hangers and Supports for Fire Suppression Piping and Equipment".
3. Space in accordance with requirements of NFPA.
4. Hangers, hanger rods, inserts and clamps constructed as approved by NFPA.

2.2 VALVES AND HOSE CONNECTIONS

A. Valves and Hose Connections - General

1. UL approved and/or FM global listed.
2. Minimum 175 psi class.
3. Outlet/inlet threads to fit local fire department standards.
4. Finish (including accessories, caps and wall plates)

    a. Rough brass.
    b. Polished brass.
    c. Rough chrome.
    d. Polished chrome plate.

B. Gate Valves

1. 2 inch and Smaller: 175 lb. UL-FM bronze, non-shock, solid wedge, OS&Y gate valve. Replaceable bronze wedge facing rings. Valve to be capable of being repacked under pressure with valve wide open. Screwed ends.
2. 2-1/2 inch and Larger: 175 lb. UL-FM iron body non-shock, solid wedge, OS&Y gate valve. Replaceable wedge facing rings and yoke bonnet. Valve to be capable of being repacked under pressure with valve wide open. Flanged ends.
3. 2-1/2 inch and Larger: 250 psi CWP, UL-FM, ductile iron body, resilient wedge, bronze mounted, OS&Y gate valve with EPDM-coated cast iron disc, grooved ends. Victaulic Series 771.

C. Butterfly Valves

1. 2 inch and Larger: 175 lb. UL-FM cast or ductile iron body butterfly, O-ring seat, alum-bronze or nickel-plated ductile iron disc, stainless steel stem, Buna-N seal, flanged.
2. 2 inch and Larger: 300 psi CWP, UL-FM ductile iron body, nickel-plated ductile iron disc, nitrile seat, stainless steel stem, weather-proof actuator housings with 2 prewired supervisory switches supervised in the open position. Victaulic Series 765 or 705.

D. Check Valves

1. 2-1/2 inch and Larger: 175 lb.. UL-FM iron body check, Buna-N seat, spring-actuated, wafer-style, or grooved-end body.
2. 2 inch and Larger: Up to 365 psi CWP, UL-FM ductile iron body, spring-actuated, stainless steel or EPDM-coated ductile iron disc, nickel-plated or welded-in nickel seat, grooved ends. Victaulic Series 717 or 717.

E. Indicator Post: 2-piece indicator post for non-rising stem gate valve, target plate OPEN and SHUT, vertical type, cast iron body with operating wrench, extension rod, and adjustable cast iron barrel of length required for depth of burial of valve.

F. Outside Clapper Type Fire Department Connections

1. Size: 4 x 2-1/2 x 2-1/2 inch.
2. Finish: Chrome-plated.
3. Lettering: Auto Sprinkler (SPKR), , Fire Department Connection as appropriate.
4. Flush wall connections.

    a. Drop clappers, cast brass body, plugs and chain, lettering
    b. Potter-Roemer 5020 Series.

5. Swing Check Valve

    a. Install on inlet of fire department connection.

b. 4-inch forged body with spring loaded brass check, body taped 1/2-inch NPT at inlet for ball drip.
c. Potter-Roemer 4500 Series.

G. Automatic Ball Drip Valve

1. Straight or angle cast brass ball drip, 1/2-inch.
2. Mount on siamese side of check valves and fire pump test header OS&Y valve.
3. Potter-Roemer 5981 or 5983.

H. Alarm Test Device

1. Single device or unit that provides visual verification of waterflow (as required by NFPA 13) in a fire sprinkler system and allows for draining of a floor section.
2. UL-listed and FM-approved.
3. Contains sight glass, inspector test valve, auxiliary drain valve and test orifice.
4. Optional replacement for conventional alarm test loop.
5. Victaulic "TestMaster".

2.3 ALARM AND SIGNAL DEVICES

A. Waterflow Detector

1. Vane type flow switch with retard mechanism or manual adjustment to prevent false alarm.
2. 175 psi rated.
3. 115 VAC rated for pilot duty only.
4. Suitable for a minimum working pressure of 175 psi.
5. Provide with contacts for remote signal wiring.
6. Potter VSR-F.
7. Provide separate contacts for alarm bell and fire alarm systems.

B. Alarm Bell

1. Audible horn alarm signal; electrically operated.
2. UL listed, 115 VAC.
3. For use with waterflow detector systems.
4. 10 inch bell.
5. Potter PBA-AC.

C. Water Motor Alarm Bell

1. Audible horn alarm signal; water powered device
2. UL/FM listed, 100 mesh strainer, 3/4-inch threaded connection.
3. For use with waterflow detector systems.
4. 9-inch bell, aluminum with red enamel finish.
5. Victaulic 760 or equal.

D. Valve Tamper Switch

1. 115 VAC/ 30 VDC
2. Switches for Butterfly Valves: Approved type.
3. Two sets of SPDT contacts.
4. Potter OSYSU-A2, Simplex 2097-9031 or Notifier NGV (OS&Y valve), Potter PIVSU-A2 or Notifier NIP (post indicator valve) supervisory switch.

E. Pressure Gages

1. Weiss Model 3 PGA-1 3-1/2-inch dial glass face, black aluminum case, 1% accuracy, bronze tube, brass socket, range 0 to 250 psig. Provide a 1/4-inch gauge cock.
2. Optional Manufacturers: Ashcroft, Trerice, Marshalltown, or Jay.

2.4 SPRINKLER HEADS

A. Sprinkler Heads - General

1. Provide heads of type required for service indicated.
2. Standard 165 deg F rating except when application requires higher rating.
3. All sprinklers to be UL and/or FM listed as required for Project.
4. Metallic fusible link or glass-bulb-type.
5. Head Application

   a. Rooms without ceilings: Type 1.
   b. Finished Rooms: Type 3 and Type 4.
   c. Clinic, Gypsum Ceilings: Type 3 and 4.
   d. Clinic, ACT Ceilings: Type 2.

6. Provide sprinklers with 1/2-inch orifice unless specifically noted otherwise.

B. Sprinkler Head Type 1

1. Upright or pendant design as required.
2. Standard bronze finish sprinkler.

C. Sprinkler Head Type 2

1. Semi-recessed pendent design, quick response.
2. 2-piece recessed escutcheon with 1/2 inch adjustment.
3. Allow removal of escutcheon and ceiling tile without disturbing head and drop assembly.
4. Chrome finish, escutcheon and sprinkler.

D. Sprinkler Head Type 3

1. Adjustable flush concealed, quick response.
2. White ceiling plate flush with finished ceiling.
3. 1/2-inch housing adjustment.
4. Chrome finish sprinkler.

E. Sprinkler Head Type 4

1. Adjustable flush concealed.
2. White ceiling plate flush with finished ceiling.
3. 1/2 inch housing adjustment.
4. Chrome finish sprinkler.

F. Tools: Furnish one emergency rubber ball shut-off on long handle to be used for temporary closing of sprinkler head after fire has been extinguished.

G. Sprinkler Cabinet: Provide spare heads of each type and sprinkler wrench for each type in quantity required by NFPA 13.

H. Sprinkler Head Guards

1. Heavy-duty welded wire.
2. Red baked enamel finish.
3. Reliance Model B, sprinkler guards.
4. Provide for all heads in electrical, telephone, communication and mechanical rooms.

I. Sprinkler escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer.

2.5 FLEXIBLE SPRINKLER DROPS

A. In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic AquaFlex® stainless steel, multiple-use sprinkler fitting system may be used to locate sprinklers as required by final finished ceiling tiles and walls.

B. The drop system shall consist of a braided or unbraided (corrugated) type 304 stainless steel flexible tube, a zinc-plated steel 1-inch NPT male threaded nipple for connection to branch-line piping, and a zinc-plated steel reducer with a 1/2-inch or 3/4-inch NPT female thread for connection to the sprinkler head.

C. The flexible drop must be listed for a minimum of three 90-degree bends to assure proper installation. Union joints shall be provided for ease of installation.

D. The flexible drop shall attach to the ceiling grid using a one-piece open gate bracket (the bracket shall allow for sprinkler installation before or after the bracket is secured to the sprinkler grid).

E. The braided drop system is FM approved for sprinkler services to 20 psi and can be installed without the use of tools, and the corrugated system is UL listed for sprinkler services to 175 psi. All hoses shall be factory-pressure tested to 400 psi.

2.6 ACCEPTABLE MANUFACTURERS

A. Alarm Valves, Wet Systems, and Deluge Valves: Reliable, Grinnell/Gem, Globe Fire Equipment Co., Viking Corp., Victaulic.

B. Alarm and Signal Devices: Federal Signal Corp., Potter Electric Signal Co., Viking, Grinnell, Simplex, System Sensor.

C. Sprinkler Heads: Globe Fire Equipment Co., Tyco, Viking Corp., Reliable, Victaulic.

D. Flexible Sprinkler Drops: Victaulic Aquaflex®, Flexhead Industries, Viking.

E. Valves: Clow, Crane, DeZurik, Nibco, Mueller, Kennedy, Stockham, Victaulic.

PART 3 - EXECUTION

3.1 GENERAL

A. Cooperate with other trades to ensure adequate space for equipment and piping placement.

B. Review plans, specifications, and shop drawings of other trades to coordinate work.

C. Install in strict accordance with approved shop drawings.

D. Install all piping, valves, and connections from mains to building fire protection systems.

E. Do not begin installation until all Agency approvals are submitted to A/E.

3.2 INSTALLATION OF PIPING, VALVES, AND ACCESSORIES

A. Install sprinkler piping to comply with applicable Codes and Standards.

1. Offset, crossover and otherwise route piping to install system in available space.
2. Pitch all branch lines, cross mains, feed mains and risers to drainage points.
3. Provide angle drain valves at all low points.
4. Plugs permitted at offsets when approved by local authority.
5. Coordinate pipe routing with other trades prior to fabrication or installation.

B. Provide OS&Y or butterfly valve and flow switch within sprinkler system at each of following locations:

1. Each zone takeoff within sprinkler piping system.
2. Each sprinkler branch take-off from fire hose standpipe within combination sprinkler standpipe system.
3. Base of all sprinkler risers.

C. Install tamper switch on each OS&Y or butterfly valve within system, including sprinkler control, sprinkler zone, and isolation valves and post indicator valve.

D. Provide auto ball drip valves at outside fire department connections between hose connection and check and shut-off valve.

E. Flush outside fire water mains prior to connecting to inside system.

F. Provide valve boxes at each outside (underground) valve.

G. Install indicator posts approximately 3 ft. above grade.

H. Install pressure gages at top of each sprinkler risers and elsewhere as required by local authority.

I. Install piping to sprinkler heads in laundry and trash chutes.

J. Provide sprinklers under ductwork over 4 feet wide.

3.3 SPRINKLER INSTALLATION

A. Install in accordance with approved Shop Drawings.

1. Modifications to system design or arrangement after approval of Drawings by local authority, may only be made after receiving written approval of authority and A/E.
2. Such modifications do not include minor relocations in piping or head placement.
3. Make all revisions in accordance with NFPA 13.

B. Install approved dirt legs and drain valves at low points of all piping to permit complete drainage of system without disconnection of any piping.

1. Drain valves at base of risers to have 1-1/2 inch hose adapters matching threads of hose systems in buildings.

C. Extend 2-inch main drain(s) to exterior of building. Extend 1-inch inspector's tests connections on ends of sprinkler branches to nearest floor drain, janitor's sink, or exterior of building.

1. Label valves and outlets

D. Provide chrome plated escutcheon plates at pipe penetrations of ceilings, floors, and walls.

E. Firestop penetrations in accordance with Division 21 Section “Hangers and Supports for Fire Suppression Piping and Equipment”.

F. Locate heads centered in ceiling tile and in center of metal strip in linear metal ceilings, if such location makes added heads necessary, provide all added heads as required to meet code.

G. Relocate heads if necessary to coordinate with ceiling layout.

H. Install sprinkler heads to provide and maintain minimum 18-inch clear between bottom of deflector and top of storage, files, shelving and cabinets.

I. Install sprinklers at the base of hydraulic elevators.

J. Do not install sprinklers or associated piping above electrical switchgear.

3.4 ELECTRICAL WIRING

A. Electrical Contractor to provide:

1. Supervised wiring from main waterflow indicator to outside alarm bell and fire alarm panel.
2. Supervised wiring from sprinkler flow switches to fire alarm panel.
3. Supervised wiring from valve tamper switches to fire alarm panel.

B. Fire Protection Contractor to be responsible for:

1. Wiring diagrams for all devices
2. All other wiring not specified to provide an operating system

3.5 FIELD QUALITY CONTROL

A. Upon completion of sprinkler system installation, the Contractor is to test the entire system per NFPA 13 requirements. Contractor is to notify the authority having jurisdiction and the Owner's representative of time and date system testing will be performed so that tests can be witnessed by same. Contractor to complete the "Contractor's Material and Test Certificate" and have signed by the authority having jurisdiction, Owner's representative, and Contractor who witnessed the testing. Copies are to be made of the Certificate and distributed to the approving authority and Owner's representative.

B. Test sprinkler piping, including outside supplies, under hydrostatic pressure to 200 psi for 2 hours.

1. Prove system tight to satisfaction of A/E.
2. Inside piping to show no leakage.
3. Leakage in underground piping in accordance with NFPA 24.

C. Test complete alarm system including control and signal circuits wired by Electrical Contractor.

1. Coordinate with electrical.
2. Complete testing prior to acceptance by Owner.

D. Give advance notice and arrange for field tests and inspections by local authority.

E. Flushing and sterilization of fire system water lines to be as required by NFPA 13.

F. Provide flow information for fire protection system including static pressure, residual pressure, and flow volumes. Tests to be conducted during high usage time of day.

3.6 PAINTING

A. Refer to Division 09 Section “Interior Painting”.

END OF SECTION 211313

DIVISION 22

PLUMBING

SECTION 220501 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 ALTERNATES

A. Within the forms of their bid proposals, contractors shall state the total (labor and material) amount, (with markups), to be added to or deducted from the base bid amount for each of the alternates indicated herein or within the Bid Form or Instructions to Bidders, that the Owner may or may not decide to accept.

1.3 UNIT PRICES

A. Within the forms of their bid proposals, contractors shall state the total labor and material unit price (with markups) for each of the unit scope-of-work items that might be added or deducted on a unit-by-unit basis during the construction period of the project, that takes place before final inspection or date of acceptance review. See Bid Form or Instructions to Bidders as relates to these unit cost items.

1. Indicate all unit costs, including controls, wiring and interlocks, as outlined and referenced within the bid form or Instruction to Bidders.

1.4 GUARANTEE

A. In entering into a contract covering this work, the Contractor accepts the Specifications and Drawings and guarantees that the work will be carried out in accordance with the requirements of the Specifications and Drawings or such authorized modifications as may be made in the Contract Documents. Contractor further guarantees that the workmanship and material will be first class and that only experienced workers, familiar with each particular class of work, will be employed. Contractor further guarantees to replace and make good at his/her own expense any defects due to faulty workmanship or material which may develop within one (1) year after final payment and acceptance by the Owner, upon receipt of written notification of defect from the Owner.

1.5 QUALITY ASSURANCE

A. Regulations and Standards: All equipment, apparatus, and systems are to be fabricated and installed in complete accordance with fire and insurance rules and regulations, the Life Safety Code, and the latest edition or revision of the following applicable regulations, standards, and codes:

1.	AIA	American Institute of Architects
2.	ASME	American Society of Mechanical Engineers
3.	ASTM	American Society for Testing and Materials
4.	NFPA	National Fire Protection Association
5.	NEC	National Electric Code
6.	OSHA	Occupational Safety and Health Administration
7.	UL	Underwriter's Laboratories, Inc.
8.	MCAA	Mechanical Contractors Association of America, Inc.
9.	ANSI	American National Standard Institute
10.	MSSV	Manufacturer's Standardization Society of the Valve and Fitting Industry
11.	AWWA	American Water Works Association
12.	AGA	American Natural Gas Association

13. PDI Plumbing and Drainage Institute
14. NACE National Association of Corrosion Engineers
15. State and Local Inspection Authorities
16. Division 01 Sections “Regulatory Requirements: and “Reference Standards” of the Project Specifications
17. References on the Drawings or in the Specifications to "code" or "building code" not otherwise identified shall mean the specific codes applicable to this Project location, together with all additions, amendments, changes, and interpretations adopted by code authorities having jurisdiction over this Project.
18. The applicable edition of all codes shall be that adopted at the time of issuance of permits by the authorities having jurisdiction and shall include all modifications and additions adopted by that jurisdiction.
19. Give all required notices so as to comply with, and meet, all inspections required by Federal, State, and Local authorities.
20. It is not the intent herewith to modify, reduce, or change any rules, standards, regulations, or requirements that are applicable under local, state, and federal codes, ordinances, or regulations of the various authorities having jurisdiction. Where the standards differ among the various authorities, the most restrictive shall apply. Where the requirements shown on the Drawings or called for in the Specifications exceed code requirements, these Drawings and Specifications shall take precedence. Where the requirements within the specifications of this division of work and the Drawings conflict with the referenced Divisions, Sections, and other documents, the documents having the most restrictive and the higher cost requirements shall apply.

1.6 JOB CONDITIONS AND COORDINATION

A. Local Conditions

1. Each Trade Contractor is to inform themself of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work to be done.
2. Contractors shall coordinate and review indicated utility data with the local utility companies.

B. Present Job Site Inspection

1. Each contractor shall schedule through the Owner a visit to the present site proposed for the work before presenting a Bid and shall make a careful inspection of the existing conditions.
2. During the site visit, each Trade Contractor is to investigate for any existing conditions and responsibilities which are not clearly defined by the Drawings and Specifications. If any such conditions exist, he/she shall bring them to the attention of the A/E in writing. The A/E will then make the required written clarification. The absence of questions before the opening of bids shall indicate a clear understanding of the scope of work and the Contractor's responsibility.

C. Concrete Housekeeping Pads and Supporting Foundations

1. Unless otherwise specified or noted on the Drawings, the Contractor or Subcontractor whose equipment the concrete pad or foundation services is to locate, size, and pay the Concrete Contractor to provide concrete pads and foundations as indicated on the Drawings for all of their equipment.
2. Concrete pads as may be indicated are based upon the design and layout-based manufacturer and model of equipment and devices as specified or as scheduled or noted on the Drawings.
3. The individual Trade Contractor furnishing the equipment or devices is to verify and coordinate all concrete pad sizes so as to have same of proper size to serve the equipment or device supplied and verify the position of all anchor bolts.

4. Any additional cost for larger than indicated pad or foundation sizes to fit the approved manufacturer and model of the equipment or devices is to be borne by the Trade Contractor who supplies such equipment or devices.

D. Permits and Fees: This Contractor is to obtain all permits and pay all fees required for the work under Division 22 of the Work.

E. Royalties and Patents

1. The Trade Contractor is to pay all royalties and license fees. He/She shall defend, indemnify, and hold the Owner and A/E harmless from any and all suits, demands or claims for infringement of any patent rights.
2. The review by A/E or Owner of any method of construction, invention, appliance, process, article, device or material of any kind is to be for adequacy of work, and is not to be construed as an approval of the use thereof by the Contractor in violation of any patent or other rights of any third person.

F. Wiring and Conduit Requirements: In general, most wiring and conduit requirements are addressed, either upon the Drawings as a part of a packaged equipment assembly specifications, or within ***Divisions 26, 27, and 28*** of the Specifications. However, should an equipment component, panel, or system device need additional wiring and conduit so as to be complete, approved and fully operational, the Contractor who supplied the equipment component, panel or system device shall be responsible for the required wiring and conduit as well as circuit disconnect and protection for same when it is not otherwise covered by the Project Drawings and Specifications.

G. Coordination: Coordinate the exact location of this work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.

1.7 SPECIFICATIONS AND DRAWINGS

A. These specifications and Drawings are intended to describe and provide for a complete and finished project. They are intended to be complementary. All items of work called for by either shall be as binding as if called for by both. The work described shall be complete in every detail, notwithstanding the fact that every item necessarily involved is not particularly mentioned or shown.

1. If the Bidder, Supplier or Contractor sees anything to question, it must be brought to the attention of the A/E immediately.

B. Minor Deviations: The Drawings accompanying these Specifications indicate the general design and arrangement of equipment, apparatus, fixtures, accessories and piping necessary to complete the installation of the system. The exact location or arrangement of the apparatus and equipment, unless otherwise dimensioned, is subject to minor changes necessitated by field conditions and shall be required without additional cost to the Owner. Measurements shall be verified through actual observation at the construction site. Each Trade Contractor shall be responsible for fitting all of his work into place in a satisfactory and workmanlike manner, to the approval of the A/E and Owner.

C. Provide all labor and materials necessary for the completion of the work described. Referenced codes and industry standards and methods shall apply when no other specifics are indicated. Bring questions relating to this paragraph to the attention of the A/E for resolution prior to the receipt of Bids.

D. All Work indicated on Drawings, diagrams, or details in part only are to continue throughout unless distinctly marked otherwise. The same applies to other parts of the project where merely a typical

reference plan, diagram, or section of the drawing is complete. The balance is intended to be the same as the typical plan, section, or diagram as shown and is to be figured accordingly.

E. The specifications are divided into trades and divisions only for the distinct purpose of facilitating the work. However, the Trade Contractor will become responsible for furnishing all labor and materials necessary to complete the project as contemplated by the Drawings and Specifications. Any item mentioned under any heading of the Specifications must be supplied even though it is not called for again under the heading for the respective work.

F. Should discrepancies occur within the Contract Documents, the more stringent and more costly approach shall apply for bidding purposes. The Contractor is to notify the A/E of discrepancies for clarification. Clarifications issued after the Contract is awarded shall be incorporated by the Contractor at no additional costs and shall be reviewed by the A/E to determine if a reduction in cost is justified.

1.8 TRADE CONTRACTORS, SUBCONTRACTORS AND SUPPLIERS

A. The Trade Contractor is any person or organization who contracts to perform work for the Project. Wherever the word "Contractor" is used on the Drawings or in the Specifications, it shall be construed to mean the Trade Contractor applicable to the Title Division of these specifications.

B. A Sub-Contractor is a person or organization who has a direct contract with a Trade Contractor to perform any of the Work at the site and includes all who furnish material worked to a special design in accordance with the Drawings and Specifications, but excludes suppliers or persons furnishing material not specially designed. Wherever the term "Sub-Contractor" is encountered in the Contract Documents, it shall mean the Sub-Contractor and/or his Sub-Sub-Contractors and/or his Material Suppliers.

C. A Sub-Sub-Contractor is a person or organization who has a direct or indirect contract with a Sub-Contractor to perform any of the Work at the project site or for the subject project.

D. A Material Supplier is a person or organization who has a direct contract with a Trade Contractor to furnish material not specially designed.

E. It shall be the responsibility of each Trade Contractor to be fully familiar with various local trade jurisdictional requirements and to engage the services of any other Sub-Contractors as may be required within the various trades to complete all of the work as indicated upon the Drawings and within the Specifications under his respective division or section. Only Trade Sub-Contractors with established knowledge and skills of their specific trade shall be used, so that all work is performed in a complete, finished, and professional manner.

F. Whenever any provisions of the Specifications conflict with any agreements or regulations in force among members of any Trade Associations, Unions, or Councils which regulate or distinguish what work shall or shall not be included in the work of any particular trade, the Trade Contractor shall make all necessary efforts to reconcile any such conflict without delay, damage or cost to the Owner.

G. If the progress of the work is affected by any undue delay in furnishing or installing any items of material or equipment required under the contract because of a conflict involving any such agreement or regulation, the A/E may require that other material or equipment of equal kind and quality be provided at no additional cost to the Owner.

H. Any Trade Contractor, subcontractor, or material supplier not normally employing union labor shall make all provisions necessary to avoid any resulting disputes with labor unions and shall be responsible for any delays, damages or extra cost caused by employment of such non-union labor, except as otherwise governable by state or federal rules and regulations.

I. Each Trade Contractor shall pay for all applicable Federal, State and local taxes on all materials, labor or services furnished by him/her, and all taxes arising out of his operations under the Contract Documents which may be imposed upon or collectable from the Owner or become a lien against his property. Such taxes shall include, but not be limited to, Occupational, Sales, Use, Excise, Social Security and Unemployment Taxes, customs duties, and all income taxes and other taxes now in force or enacted prior to final acceptance of the work. The Trade Contractor shall assume all liability for the payment of and shall pay any unemployment benefits payable under any Federal or State law to individuals employed by him/her during the progress of the work covered by the Contract.

J. It is the responsibility of each Trade Contractor to coordinate the various related equipment requirements between his subcontractors, suppliers, and other trade contractors, and to also follow the approved manufacturer's installation instructions.

1.9 OPERATIONAL AND MAINTENANCE INSTRUCTIONS

A. All operational and maintenance instructions that are provided to various Owner-selected members of the facility engineering and/or maintenance staff are, at the same time presented, to be fully videotaped by the Contractor so that all such sessions can be later reviewed by the Owner's staff on a retraining basis as needed. All such videotapes are to become the property of the Owner at the end of each applicable training period, with one copy of each also being supplied to the A/E for the A/E project files.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/PRODUCTS/SUBMITTALS

A. Under the Base Bid, no other manufacturers except those indicated on the Drawings or those listed within the Sections of this Division, that are, in turn, able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable. In addition to specific required "Alternates," proposed substitutions that may or may not be acceptable to the Owner may be submitted by the Contractor only at the time of initial base bid submittal.

B. Although design-based models of various manufacturers may be indicated within the various schedules, it is the responsibility of the various equipment manufacturers to verify the model selections so that all items of equipment comply with the minimum standards of performance that are indicated within the schedules, as well as the requirements within various sections of the specifications under which the equipment is also specified.

C. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

D. Shop Drawings are to be submitted on each item of specified or scheduled equipment, valves, specialties, insulation, fixtures, drains, controls and related accessories. All control submittals must include a typed sequence of control for each system.

E. Coordination and Fabrication Drawings: Prepare layout drawings of all system assemblies of this Contract including plumbing, heating, sprinkler piping, electrical and technology, mechanical and electrical room layouts with equipment and piping, ductwork installations, and control systems. Include completely dimensioned plans drawn to scale. Show elevations and sections indicating locations of all equipment, piping, ductwork, drains, controls, and other items with reference to columns, walls, slabs, beams, and to components of other systems and work of other trades. Floor plans shall be drawn at not less than 1/4 inch scale with a sign-off block including all disciplines and date. Tracing or reproduction of Construction Documents is not acceptable. Provide a minimum of one reproducible drawing and five prints of each drawing.

2.2 ACCESS DOORS AND PANELS

A. Unless otherwise indicated, each Trade Contractor is to locate and furnish all access doors required for non-accessible surfaces (such as ceilings, walls, chases, and similar locations), so that all valves and similar items are easily accessible for operation, inspection and maintenance. Access doors for ceiling, walls, chases, etc. are to be installed by the General Contractor. The Trade Contractor is to bear the costs of the installation of the access doors.

B. See Section 08 3113 for access door types and specifications. Minimum size to be 12 inch x 12 inch, or as indicated or required to allow inspection of items served.

2.3 SLEEVES

A. Each Contractor is to provide properly sized, secured and firestopped sleeves for all of their piping systems at all penetrations of walls, foundations, partitions, floors and roofs throughout the entire facility.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all materials, labor, equipment, and services necessary for a complete and operable installation as specified and shown on the Drawings. The word "Provide" shall mean "Furnish and install."

B. Provide new material and equipment in strict accordance with these Specifications and the Project Drawings.

C. At all times, take such precautions as are necessary to protect materials from damage. Close all pipe openings to prevent obstructions and contamination.

3.2 CUTTING AND PATCHING IN BUILDINGS

A. Each Contractor is responsible for all costs associated with the necessary cutting and patching as required for the installation of his work, unless otherwise indicated.

B. Patching is to be performed by the trade proper for each material to be patched. Patching shall leave premises and finishes in a complete and neat condition comparable to the original. Painting of patched surfaces to be by the painting sub-contractor of the General Contractor, unless otherwise specifically indicated or the plumbing/fire protection contractor is the prime contractor for the project. Maintain the fire integrity of all walls, floors, ceilings, and partitions.

3.3 PROTECTION

A. Protect equipment and trim against damage and injury due to building materials, acid, tools, equipment and any causes incidental to construction. Cover the finished surface of each piece of equipment with building paper or similar protection. Replace all equipment damaged by any cause and any trim with marred or scratched finish at no cost to the Owner, upon receipt of written notification from the A/E.

B. Where materials to be installed are being stored at or near the project during construction, arrange such materials so as to minimize the possibility of contamination, corrosion and damage. Keep ends of pipe, equipment, and specialties properly closed during construction and installation to avoid the possibility of miscellaneous materials being placed in the openings.

3.4 PAINTING

A. See Division 09 Section “Interior Painting”.

3.5 ADJUST AND CLEAN

A. Inspect all equipment and put in satisfactory working order.

1. Clean all exposed and concealed items.
2. Clean floor drains, cleanouts, and plumbing fixtures.
3. Clean specialties such as traps and strainers and all equipment surfaces such as pumps, motors, etc.
4. Clean all covers.
5. Clean exposed piping.
6. Adjust pumps, balancing valves, and metering faucets for proper flow rates.
7. Adjust water heaters and thermostatic mixing valves for required temperatures.

END OF SECTION 220501

SECTION 22 05 07 - EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Each Trade Contractor is to provide all excavating, trenching, sheeting, bracing, pumping, and backfilling as required for the installation of their work.

1.3 QUALITY ASSURANCE

A. Testing

1. All testing is to be done by an independent testing laboratory employed by this Contractor and approved by the Owner and A/E.
2. Conduct up to 10 tests per Trade per 40,000 gross square foot of compacted surface serving each Trade's specific area of work to determine the compaction density of backfill.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

C. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

H. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Yellow: Gas, oil, and dangerous materials.
2. Blue: Water systems.
3. Green: Sewer systems.

PART 3 - EXECUTION

3.1 GENERAL PROTECTION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by A/E. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by A/E.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, damp proofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under steps and ramps, use engineered fill.
2. Under building slabs, use engineered fill.
3. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by A/E; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 220507

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT MOTORS

A. Motors shall be of sufficient size for the duty to be performed and shall not exceed the motor's full-rated load when the driven equipment is operating at specified capacity under the most severe conditions likely to be encountered. Motors shall be established, U.S.-manufactured industry standard types for the service intended, having normal starting torque and low starting current characteristics, unless other characteristics are specified. When electrically driven equipment is furnished which materially differs from the contemplated design, the Contractor supplying the driving equipment shall pay for and make necessary the adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed. Motors and equipment shall meet NEMA MG1, and State and Local Energy Code minimum COP requirements. Provide suitable overload protection for each motor.

B. Unless otherwise specified or noted on the Drawings, motors shall be suitable for the service intended, shall be of latest industry standards of design for maximum energy efficiency, and shall be continuous-duty-type, as follows:

1. Motors less than 1/2 HP shall normally be 120-volt, 1-phase, 60-HZ.

C. Coordinate and verify voltage and phase required with Electrical Drawings, as well as equipment scheduled data.

D. It shall be the responsibility of this contractor to coordinate and verify the applicable phase and voltage requirements with the electrical contractor before submittal of Shop Drawings.

2.2 MOTOR CONTROLLERS AND DISCONNECTS

A. Except as otherwise specified in each of the various sections of Division 22, motor controllers and disconnects shall be as specified under Divisions 26, 27 and 28.

B. Verify applicable voltage, phase, and protective device requirements with electrical contractor before manufacture or installation of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with manufacturer's latest published instructions and all applicable inspection and code authority requirements.

3.2 MOTOR EFFICIENCIES

A. Drip-Proof Motors

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	84.0
2	84.0	1-1/2	84.0
3	86.0	2	84.0
5	87.0	3	88.0
7-1/2	87.0	5	88.0
10	88.0	7-1/2	90.0
15	90.0	10	90.0
20	90.0	15	91.0
25	91.0	20	91.0
30	91.0	25	93.0
40	91.0	30	93.0
50	91.0	40	93.0
60	92.0	50	94.0
75	93.0	60	94.0
100	93.0	75	94.0
		100	94.0

Totally Enclosed, Fan-Cooled Motors

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	81.0
2	84.0	1-1/2	84.0
3	84.0	2	82.0
5	86.0	3	82.0
7-1/2	88.0	5	85.0
10	90.0	7-1/2	87.0
15	91.0	10	89.0
20	91.0	15	91.0
25	91.0	20	92.0
30	92.0	25	92.0
40	92.0	30	93.0
50	93.0	40	93.0
60	93.0	50	94.0
75	94.0	60	94.0
100	94.0	75	94.0
125	95.0	100	95.0
150	95.0	125	95.0
200	95.0	150	95.0
		200	95.0

END OF SECTION 220513

SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section the includes the following types of meters and gauges:

1. Temperature gauges and fittings.
2. Pressure gauges and fittings.

B. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 specifications.

1.3 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment and material item specified.

B. Product Data: Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

C. Samples: Not required for review.

D. Contract Close-Out Information

1. Maintenance data for each type of meter and gauge in each building for inclusion in Operating and Maintenance Manuals specified in Division 01, and Division 22 Section "Common Work Results for Plumbing".
2. Portable test plug test kit and portable meter receipts as described in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Thermometers

a. Marshalltown Instruments, Inc.
b. Trerice (H.O.) Co.

c. Weiss Instruments, Inc.

2. Thermometer Wells: Same as thermometers.

a. Insertion Dial Thermometers.
b. Ashcroft Dresser Industries/Instrument Div.
c. Trerice (H.O.) Co.
d. Weiss Instruments, Inc.

3. Pressure Gauges

a. Ametek, U.S. Gauge Div.
b. Ashcroft Dresser Industries/Instrument Div.
c. Marsh Instrument Co., Unit of General Signal.
d. Marshalltown Instruments, Inc.
e. Trerice (H.O.) Co.
f. Weiss Instruments, Inc.

4. Pressure Gauge Accessories: Same as for pressure gauges.

a. Water Orifice-Type Measurement System.
b. Armstrong Pumps, Inc.
c. Bell & Gossett, ITT, Fluid Handling Div.

5. Test Plugs

a. MG Piping Products Co.
b. Peterson Equipment Co., Inc.
c. Sisco, A Spedco, Inc. Co.
d. Trerice (H.O.) Co.
e. Watts Regulator Co.
f. Flow Design, Inc.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.

1. Scale Range: Temperature ranges for services listed as follows:
2. Domestic Hot Water: 30 deg to 240 deg with 2 deg scale divisions (0 deg to 115deg C with 1 deg scale divisions).
3. Domestic Cold Water: 0 deg to 100 deg F with 2 deg scale divisions (minus 18 deg to 38 deg C with 1 deg scale divisions).

2.3 THERMOMETERS

A. Case: Die-cast, aluminum finished in baked epoxy enamel, glass front, spring-secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, organic liquid-filled magnifying lens.

D. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal stainless steel case and stem, 1-inch diameter dial, dust and leakproof, 1/8-inch diameter tapered-end stem with nominal length of 5 inches.

2.5 THERMOMETER WELLS

A. Brass or stainless steel, pressure-rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.6 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube-type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inch diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1% of range span.

F. Range: Conform to the following:

1. Vacuum: 30 inch Hg to 15 psi
2. All fluids: 2 times operating pressure

2.7 PRESSURE GAUGE ACCESSORIES

A. Siphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.8 TEST PLUGS

A. Test plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and two self-sealing valve-type core inserts suitable for inserting a 1/8 inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:

1. Air, Water, Oil, and Gas, 20 deg to 200 deg F (minus 7 deg to 93 deg C): Neoprene
2. Air and Water, minus 30 deg to 275 deg F (minus 35 deg to 136 deg C): EPDM

C. Ranges of pressure gauge and thermometers shall be approximately two times systems operating conditions.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most legible position.

B. Install pressure gauges at top of hot and cold water risers.

C. Install pressure gauge at incoming water service.

D. Pressure Gauge Needle Valves: Install in piping tee with snubber.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most legible position. Secure cap.

1. Install test plugs adjacent to each piping point where a temperature sensing device is required by control specifications.

B. Test Kit: Provide test kit consisting of one pressure gauge, gauge adapter with probe, two bimetal dial thermometers, and carrying case. Turn over to Owner at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gauges piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 QUALITY ASSURANCE

A. Valve Bodies, Shells and Seats: Factory-tested.

B. Standard for 125 psi and 150 psi saturated steam rated valve pressure containing parts: ASTM B62.

C. Standard for 200 psi and 300 psi valves with metallic seats: ASTM B61.

D. Iron Body Valves

1. Pressure-Containing Parts: ASTM A126, Grade B.
2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71.
4. Use domestically manufactured valves where required by a Buy American Plan.

E. Butterfly Valves

1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

F. Valve Stems: ASTM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

G. Pressure Castings: Free of impregnating materials.

H. Manufacturer's name or trademark and working pressure stamped or cast into body.

I. 42 USC 300G: The Reduction of Lead in Drinking Water Act.

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data

1. Manufacturer's cut sheets and/or literature.
2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
2. Operating and maintenance manuals.

1.4 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position valves for equipment clearance and accessibility as well as system and valve operational conditions.

B. Valve manufacturer to verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data for valve shall take precedence over indicated figure or model number. Provide proper seat and seal material for applicable temperature, pressure and service indicated for each valve application.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Gate, Butterfly, Check & Ball Valves: Stockham, Nibco, Hammond, Crane, Jenkins, Powell, Milwaukee, Homestead, Apollo, Mueller, A. Y. McDonald.
   1. Within the clinic:
      a. Ball Valves: #585-66-LF series, 600 psi, wog, bronze body, full-port, bronze trim and two-piece body.
      b. Check Valves: NIBCO #S-433, 300 psi wog, bronze body, horizontal swing, y-pattern, renewable seat and disc and bronze trim.
      c. Circuit Setters: Bell and Gossett model CB.
      d. Water Pressure Regulating Valve: Wilkins no. 500 YSBR, 300 psi water, bronze body, nylon reinforced neoprene diaphragm, complete with bronze body strainer and monel screen.

2.2 DOMESTIC WATER VALVES

A. For gauge valves within steel or copper lines of 1/8 inch or 1/4 inch size, threaded or solder, 150 psig steam or 300 psig w.o.g., union bonnet, integral seat, renewable seat and disc, bronze globe valve conforming to MSS-SP-80, ASTM B-62.

B. For service valves within steel piping of 1/4 inch through 2-1/2 inch size; two-piece ball valve with bronze FNPT threaded ends, lever handle, stainless steel ball and stem, Class 150 SWP-600 w.o.g.

C. For service valves within 1/4 inch through 2 inch size copper piping, similar to above except for solder ends.

D. For service valves in copper piping 2-1/2 inch through 4 inch size; 200 psi w.o.g. butterfly valve, wafer body, suitable for dead-end and isolation service.

E. For service valves within steel piping of 3 inch or above; 200 psig w.o.g butterfly valves, installed between standard ANSI Class 125/150 flanges, suitable for dead-end and isolation service without use of downstream flanges. 3 inch through 6 inch size valves to have manual stem position, lock to prevent tampering, notched plate and latching handle while valves of 8 inch size and above shall have manual enclosed weatherproof handwheel actuators with gear box and position indicator window, and all meeting the following criteria.

	Part	Specifications
1.	Stem	Stainless Steel, ASTM A-582 Type 410
2.	Collar Bushing	Brass, ASTM B-124
3.	Stem Seal	EPDM
4.	Body Seal	EPDM
5.	Nameplate	Aluminum
6.	Upper Bushing	Copper CDA 122
7.	Liner	EPDM
8.	Disc	Al. Bronze, ASTM B-148 Alloy 954/955
9.	Lower Bushing	Copper CDA 122
10.	Body (Lug)	Ductile iron, ASTM A-536

F. For check valves within horizontal steel or copper lines through 2 inch size, bronze check valve with teflon disc, threaded ends, Class 150 swp-300 w.o.g., as follows:

	Part	Material	Specifications
1.	Body	Bronze	ASTM B62
2.	Cap	Bronze	ASTM B62
3.	Lever	Bronze	Commercial
4.	Disc	Teflon	
5.	Disc Holder	Brass	ASTM B16 1/4 inch & 1/2 inch
		Bronze	ASTM B62 3/4 inch to 2 inch incl
6.	Pin	Stainless Steel	Commercial
7.	Plug	Bronze	ASTM B16
8.	Retaining Ring	Stainless Steel	Commercial
9.	Disc Nut	Bronze	Commercial

G. Optional check valves for vertical type of installation within steel or copper lines, similar to that of above sub-paragraph G, except vertical lift up-flow, bronze with threaded ends.

H. For check valves within steel piping of 2-1/2 inch size and above, for vertical up-flow applications, Class 250 w.o.g flanged iron body flat style silent check; and for horizontal applications, Class 125 w.o.g flanged iron body horizontal swing check.

I. For check valves within copper piping of 2-1/2 inch through 4 inch size, Class 300 w.o.g bronze for horizontal or vertical installation with solder ends.

2.3 NATURAL GAS SYSTEM

A. All types of valves used shall be local utility company as well as AGA approved for the service and pressure intended.

B. Refer to Division 22 Section “Facility Natural Gas System”.

2.4 OPERATORS

A. Provide operators for valves 4 inch and larger located in mechanical spaces installed 8 feet or higher above floor.

B. Provide chain lever or chain sprocket operator with sufficient chain to reach within 5 feet of floor.

C. Remote operator accessories are to be by same manufacturer as valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with manufacturer's written instructions, and all valves must be suitable for the service intended.

B. Provide service (isolation) valve at every piece of equipment. Service valves to be positioned in a manner to allow for ease of service and removal of equipment with minimum disruption of the piping system.

C. All shut-off valves in plumbing water systems 2 inch and smaller shall be ball-type.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 22 Sections “Vibration Controls for Plumbing Piping and Equipment” and “Seismic Restraint” for additional requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:

1. Pipe hanger and supports.
2. Pipe and equipment anchors.
3. Pipe sleeves.

B. All equipment, piping, and ductwork shall be supported and seismically braced as noted in Division 22 Section “Seismic Restraint”.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. NPFA

D. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA’s engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.4 SUBMITTALS

A. Shop Drawings

1. Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members.
2. Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Operating and maintenance data.
2. Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers (Non-Corrosive Environment): Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Stainless Steel Pipe Hangers (Corrosive Environment): American Stainless & Supply, FM Stainless, National Pipe Hanger Corp.

C. Concrete Anchors: Phillips, Hilti.

D. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

E. Pipe and Equipment Anchors

1. Shop-fabricated.
2. Field-fabricated.

F. Sleeves

1. Shamrock Industries, "Crete-sleeve" plastic hole forms.
2. Proset Systems Inc., "Proset" fire-safe pipe penetrations.
3. Shop for field fabricated.

G. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc., or equal.

2.2 PIPE HANGERS

A. General

1. Materials, Design and Manufacture: MSS SP-58.
2. Fabrication and Installation: MSS SP-89.
3. Selection and Application: MSS SP-69.
4. Hangers Used Directly on Copper Pipe: Copper or cadmium-plated.
5. All Other Hangers and Channels, Angles, and Supporting Steel: Cadmium-plated or galvanized, except in corrosive environment.
6. All Hanger Rods of Continuous Thread Type: Electro-galvanize or cadmium-plate after threads are cut, except in corrosive environment.
7. Galvanize all structural steel, angles, rods, channels, and hardware that are not provided with a rustproof finish, except in corrosive environment.
8. Corrosive Environment: All hangers, threaded rods, nuts, etc. to be 316 stainless steel.
9. Screw Threads on Hangers and Fittings: Conform to Class 2A and 2B of ANSI B1.1.

B. Pipe Hangers for Insulated and Bare Pipe

1. Insulated Pipe:

MSS	B-Line	ANVIL
1	B3108	260
3	B3144	295

2. Bare Pipe:

MSS	B-Line	ANVIL
1	B3100/02 C	260
3	B3144/46	295
4	B3142	216

3. Hangers for insulated pipe to be oversized to accommodate insulation, protection shields, and/or saddles.

C. Pipe Hangers in Other Situations: See MSS-SP-69.

D. Pipe Hangers on Insulated Lines

1. Pipe Sizes 2 Inch and Less: Use pipe covering shield to protect insulation.

   a. Minimum shield length: 12 inch
   b. Minimum shield thickness: 18 ga.

2. Pipe Sizes 2-1/2 Inch and Larger: Use insulated pipe supports.

E. Hanging Rollers, Cast Iron

1. MSS Type 41.
2. B-Line B3114.
3. Anvil 171.

F. Supporting Roller, Cast Iron

1. MSS Type 44, 45, or 46.
2. B-Line B3117SL, B3117, B3118SL or B3119.
3. Anvil 271, 277, or 274.

G. Insulated Pipe Supports

1. Protect all insulated pipe at point of support by 360-degree pre-insulated pipe supports.
2. Utilize 100 psi, waterproofed calcium silicate fully encased in sheet metal shield for hot pipe applications and cellular glass with ASJ vapor barrier jacket for cold pipe applications.
3. Insert same thickness as adjoining pipe insulation.
4. Use shield length and minimum sheet metal gages indicated:

Pipe Size	Shield Length	Minimum Gage
2-1/2 - 6 inch	6 inch	20
8 - 10 inch	9 inch	16
12 - 18 inch	12 inch	16
20 inch and up	18 inch	16

5. Pipe Supported on Rod Hangers: Pipe Shields, Inc., Models A1000, A2000, A3000, A4000, and A9000.
6. Pipe Supported on Flat Surfaces: Pipe Shields, Inc., Models A1000, A2000, A5000, A6000, and A7000.
7. Pipe Supported on Pipe Rolls: Pipe Shields, Inc., Models A3000, A4000, A5000, A6000, and A8000.

H. Concrete Inserts

1. Continuous Slot Inserts

a. Anvil Power Struct PS349.
b. B-Line Figure B32I.

2. Individual Inserts

a. Anvil Figure 282, or 281.
b. Do not exceed manufacturer's recommended load on any insert.

I. Beam Clamps

1. B-Line Figure B3054 or B3055.
2. Anvil Figure 133, 218, 228, 292.

J. Attachment to “Z” Type Purlin

1. PHD Figure 290.
2. Michigan No. 315.

K. Pipe Hangers for Stainless Steel Pipe

1. Split ring type or type as recommended by pipe manufacturer.
2. Hanger shall be stainless steel or have a plastic coating to protect pipe from galvanic corrosion.

2.3 PIPE SLEEVES AND SEALANTS

A. Sleeves - General

1. Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping.
2. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:

1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping

1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.
4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.

1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.

    a. Other insulated pipes: Type CS.

3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes

1. Length: Ends flush with finished surfaces.
2. Diameter

    a. Minimum 3 inch.
    b. Minimum 1 inch larger than pipe and pipe insulation.
    c. In concrete, 1-1/2 inch larger than pipe.
    d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.

1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity.

    a. Provide proper material for each typical application as described by manufacturer.

2. Acceptable Manufacturers

    a. Base

        1) Dow Corning "Fire Stop".
        2) Nelson "Flameseal".
        3) 3M "Fire Barrier".

4) Pipe Shields Inc., Model WFB, DFB, or QDFB Series.
5) Proset Systems.

3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations

1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E.
5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction. At first elbow of equipment run out piping risers and horizontal piping within ten (10) feet of all circulating basemounted pumps having four (4) inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Standard Steel Liquid	Standard Steel Vapor	Copper Liquid	Copper Vapor
1/2 inch	7 ft.	8 ft.	5 ft.	6 ft.
3/4 inch	7 ft.	9 ft.	5 ft.	7 ft.
1 inch	7 ft.	9 ft.	6 ft.	8 ft.
1-1/4 inch	7 ft.	9 ft.	7 ft.	9 ft.
1-1/2 inch	9 ft.	12 ft.	8 ft.	10 ft.
2 inch	10 ft.	13 ft.	8 ft.	11 ft.
2-1/2 inch	11 ft	14 ft.	9 ft.	13 ft.
3 inch	12 ft.	15 ft.	10 ft.	14 ft.
4 inch	14 ft.	17 ft.	12 ft,	16 ft.
6 inch	17 ft.	21 ft.	14 ft.	20 ft.
8 inch	19 ft.	24 ft.	16 ft.	23 ft.
10 inch	22 ft.	26 ft	18 ft.	25 ft.

B. For Schedule 40 or Schedule 80 PVC or CPVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

PVC or CPVC		
Pipe Diameter	**Liquid**	**Vapor**
1/2 - 1 inch	3 ft.	3 ft.
1-1/4 - 2 inch	4 ft.	4 ft.
2-1/2 - 3 inch	4 ft.	4 ft.
3-1/2 - 4 inch	4 ft.	4 ft.
5 - 8 inch	4 ft.	4 ft.

C. Provide a hanger within one (1) foot or less of each horizontal elbow and valves that are above three (3) inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than six (6) feet, provide only one (1) hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For cast iron pressure piping, space maximum 12 feet o.c.

1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

E. For cast iron soil piping, space maximum 10 feet o.c.

1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

F. For piping of other materials, space hangers according to manufacturer's recommendations.

G. Pipe Hanger Loading

1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

H. Trapeze Hangers

1. Suspend trapeze hangers from concrete inserts of approved structural clips.
2. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

I. Vertical Pipe Supports

1. Support all vertical pipe runs in pipe chases at base of riser.
2. Support pipes for lateral movement with clamps or brackets.

J. Concrete Inserts

1. Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required.
2. Provide concrete inserts in time for installation in concrete.

3.3 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors

1. Provide as indicated and required to permit complete installation of system.
2. Do not anchor piping to plaster or gypsum wallboard partition walls.
3. Provide anchoring devices at locations indicated.
4. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.4 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts.

1. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.5 MISCELLANEOUS STEEL

A. Piping Contractor (or Plumbing Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel, except in corrosive environments where stainless steel shall be utilized. Repair galvanized steel at field cuts and connections.

3.6 SEISMIC RESTRAINTS

A. Do not mix seismic bracing designs within a new system design.

B. SMACNA shall be considered applicable for seismic design force application. Seismic force applications shall be engineered by the Contractor and submitted for approval prior to installation.

C. Provide additional bracing/stiffeners on hanger rods as recommended by SMACNA to prevent hanger bending due to vertical seismic forces.

END OF SECTION 220529

SECTION 220548 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 22 Sections “Hangers and Supports for Plumbing Piping and Equipment” and “Seismic Restraint” for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems

1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.
5. Flexible pipe connectors.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

C. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

D. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

E. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

F. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

G. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

B. Shop Drawings

1. All equipment items specified.
2. Spring Isolators

a. Spring diameter.
b. Deflection.
c. Compressed spring height.
d. Solid spring height.
e. Point location of each isolator.
f. Load at each point.
g. Field static deflection.
h. Horizontal loading and bolt requirements.
i. Indicate all bases and rail clearances.

3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
4. Special details necessary to convey complete understanding of the work to be performed.

C. Product Data

1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:

a. The equipment identification mark.
b. The isolator type.
c. The actual load.
d. The static deflection expected under the actual load.
e. Specified minimum static deflection.
f. The additional deflection to solid under actual load.
g. The ratio of spring height under actual load to spring diameter.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Closeout Information

1. Operating and maintenance data.
2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS Peak-to-Peak)
Under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
Over 2000 rpm	1

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices

1. Amber/Booth Co.
2. Korfund Dynamics Corp.
3. Mason Industries, Inc.
4. Peabody Noise Control Inc.
5. Vibration Mountings & Controls, Inc.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.

1. Acoustical sealant D.A.P.
2. BR-96 Pecora.
3. Acoustical sealant Tremco.
4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.

1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, welded concrete pouring forms and flexible pipe connectors from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:

1. All steel parts to be hot-dip galvanized.
2. All bolts to be cadmium-plated.
3. All springs to be cadmium-plated and neoprene-coated.

D. Coordinate the requirements of this Section with those of Division 22 Section “Seismic Restraint”.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators

1. Type 1 Isolators: Double-deflection neoprene mountings.

    a. Minimum static deflection: 0.35 inch.
    b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
    c. Friction pads both top and bottom to eliminate the need for bolting.
    d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.
    e. Mason Industries, Type ND; or Vibration Mountings, Type RD.

2. Type 2 Isolators: Spring-type.

    a. Free-standing and laterally stable, without any housings, snubbers, or guides.
    b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.
    c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
    d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
    e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
    f. Mason Industries, Type SLF; or Vibration Mountings and Controls, Type II, Series A.

3. Type 3 Isolators: Spring-type with vertical limit stop.

    a. Equal to Type 2 isolator, except that mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.
    b. Installed and operating heights to be the same.
    c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.
    d. Limit stops to be out of contact during normal operations.
    e. Mason Industries, Type SLR; or Vibration Mountings and Controls, Type AWR.

4. Type 4 Isolators: Neoprene wafer pads.

    a. Durometer or hardness to suit application.
    b. Square waffle pattern on 1/2-inch centers.
    c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
    d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
    e. Provide type "W" adhesive, both sides, for all non-bolted applications.
    f. Mason Industries, Type "W", "WMW", "WML", or "WM"; or Vibration Mountings, Type VM.

B. Vibration Hangers

1. Type 5 Isolators: Steel spring-type hanger.

    a. Steel spring and 0.3 inch deflection neoprene element in series.
    b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
    c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
    d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
    e. Mason Industries, Type 30N; or Vibration Mountings, Type RSH.

2. Type 6 Isolators: Precompressed steel spring-type hanger.

a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.
b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
c. Mason Industries, Type PC30N; or Vibration Mountings, Type RSHP.

3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.

a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.
d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.
f. Mason Industries, Type W30; and Vibration Mountings, Type SHP.

4. Type 8 Isolators: Double-deflection neoprene-type hanger.

a. Minimum static deflection: 0.40 inch
b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
c. Provide hanger for direct attachment to flat iron duct straps.
d. Mason Industries, Type WHD; or Vibration Mountings and Controls, Type RHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.

1. Rectangular, except for equipment which may require "T" or "L"-shaped.
2. Pump Bases for Split-Case Pumps: Provide supports for suction and discharge base ells.
3. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.
4. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.
5. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.
6. Mason Industries, Type WF; or Vibration Mountings and Controls, Type WFB.

B. Type B: Steel rail.

1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
2. Members must be sufficiently rigid to prevent strains in the equipment.
3. Mason Industries, Type ICS; or Vibration Mountings and Controls, Type WFR.

C. Type C: Structural steel and concrete base.

1. Rectangular structural beam or channel concrete forms for floating foundations.
2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.

5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2-inch above bottom, or additional steel as is required by structural conditions.
6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.
8. Mason Industries, Type K (Type BMK); or Vibration Mountings and Controls, Type WPF.

D. Type D: Curb-mounted base.

1. Factory-assembled isolation base that fits over roof curb and under the isolated equipment.
2. Provide extruded aluminum top member to overlap bottom member to provide water run-off independent of the seal.
3. Provide cadmium-plated springs with a 1-inch minimum deflection with 50% additional travel to solid.
4. Spring Diameter: Not less than 0.8 of spring height at rated load.
5. Provide resilient snubbers in corners with minimum clearance of 1/4-inch for wind resistance.
6. Provide a weather seal of continuous closed-cell sponge material both above and below base and a waterproof flexible ductlike EPDM connection.
7. Foam or other contact seals are not acceptable at spring cavity closure.
8. Mason Industries, Type CMAB; or Vibration Mountings and Controls, Type AXR.

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.

1. Construction: 4-inch-thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
2. Glass Fiber Pads

    a. Inorganic inert material with loading capacity up to 500 psig.
    b. Covered with an elastomeric coating to increase vibration dampening and to protect media.

3. Concrete Caps

    a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.
    b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12 inch o.c. each way.

4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.

1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.
2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.
3. Make isolation bases 1 ft. larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.
4. Make isolation bases minimum 1 ft.- 2 inch thick with top of pad 4 inches above finished floor slab.
5. Reinforce isolation bases as indicated in specifications and drawings.
6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4 inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:

1. Mason Industries, Type ADA.
2. Peabody Noise Control, Type RGN.
3. Vibration Mounting & Controls, Type MDPA.
4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector

1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.
5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
7. If control rods are used, they must have 1/2-inch thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.

9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joins shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.

1. Stainless steel braid and carbon steel fittings.
2. Sizes 3-inch and larger: Flanged.
3. Sizes 2-1/2-inch and less: Male nipples.
4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

PART 3 - EXECUTION

3.1 APPLICATION

A. General

1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.

    a. Minimum static deflections may be revised subject to prior approval.
    b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.

        1) Provide revised vibration control equipment to match revised or substituted equipment.
3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.

    a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.
    b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
    c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
    d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
    e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
    f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
    g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.
    h. No pipes or equipment are to be supported from other pipes or equipment.
    i. Resiliently isolated pipes are not to contact the building construction or other equipment.
    j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting pipes.

B. Major Equipment

1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.
2. Flexible pipe connections, are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Pipes

1. All piping within three support positions of a connection to a pump, compressor engine, or other rotating type equipment piping is to be supported by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
2. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral supports.
3. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
4. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently mounted.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.

1. Air compressors, 3 hp or less.
2. Vacuum pumps, 3 hp or less.
3. Minimum static deflections, 0.35 inch.

B. Use Type 2 isolators for equipment mounted on floors other than grade-supported floor slabs.

1. Air compressors, 15 hp and larger.
2. Vacuum pumps, 15 hp and larger.
3. All pumps, 30 hp and larger.
4. Minimum static deflections, 1.5 inch.

C. Use Type 3 isolators for equipment mounted on floors other than grade-supported floor slabs.

1. All boilers.
2. Minimum static deflections, 1.5 inch.

D. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.

1. Air compressors.
2. Vacuum pumps.
3. Boilers.
4. Minimum static deflections, 0.3 inch.

E. Use Type 5 vibration hangers for suspended equipment.

1. Individual runs of piping, 3-inch and smaller.
2. In-line pumps, 2 hp and smaller.
3. Minimum static deflections, 0.3 inch.

F. Use Type 6 vibration hangers for suspended equipment.

1. Trapeze-type pipe hangers.
2. Individual runs of piping, 4 inch through 6 inch.
3. Inline pumps, 3 hp through 5 hp.
4. Minimum static deflection, 1.5 inch.

G. Use Type 6 or Type 7 vibration hangers for suspended equipment.

1. Trapeze-type pipe hangers.
2. Individual runs or piping, 8 inch and larger.
3. In-line pumps, 7-1/2 hp and larger.
4. Minimum static deflection, 2.5 inch.

3.3 BASES AND RAILS

A. Use Type C concrete platforms for equipment mounted on floors other than grade supported floor slabs.

1. Air compressors, 15 hp and larger.
2. Vacuum pumps, 15 hp and larger.
3. All base-mounted pumps, 30 hp and larger.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on floors other than grade-supported floor slabs.

1. Air compressors, 5 hp through 10 hp.
2. Vacuum pumps, 5 hp through 10 hp.
3. All base-mounted pumps, 25 hp and less.

B. Use Type IP2 isolation pads for equipment mounted on grade.

1. Boilers.
2. Pump groups where one pad serves two or more pumps.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.

1. Pump Suction and Discharge

a. Exception: When two or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.

2. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.

1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.

1. Indicate specific applications on shop drawings.

3.6 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be Type 8 isolators.

B. Horizontal runs in all other locations throughout the building shall be isolated by Type 7 isolators.

C. Floor supported piping shall rest on Type 3 isolators.

D. All Type 7 isolators, or the first three Type 8 mounts, as noted above, will have same static deflection as specified for the mountings under the connected equipment.

E. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and including 3 inch; 1.5 inch deflection for pipe sizes up to and including 6 inch; and 2.5 inch deflection thereafter.

F. All other hangers and mounts will have a minimum steel spring deflection of 0.75 inch.

G. Locate hanger as close to overhead supports as is practical.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:

1. Piping identification.
2. Valve identification.
3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1-2015, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

PART 2 - PRODUCTS

2.1 PIPE MARKERS

A. Conform to ANSI A13.1-2015.

1. Pressure-sensitive vinyl (self-sticking) material.
2. Mechanically Fastened Type: Snap-on or strap-on.
   a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
3. Provide with direction of flow arrows.

4. Size of Letters Legend

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

2.2 VALVE TAGS

A. Brass or Anodized Aluminum Type

1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:

a. Service: 1/4 inch stamped black filled letters.
b. Valve numbers: 1/2 inch stamped black filled letters.

2. Aluminum: 2-inch diameter, 0.032 inch thick, with following lettering:

a. Service: 1/4 inch engraved letters.
b. Valve numbers: 1/2 inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.3 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.

1. Two 3/8-inch mounting holes.
2. Lettering size: Minimum 1/2-inch high.
3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.4 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

2.5 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers

1. Craftmark Identification Systems.
2. W. H. Brady Co.
3. EMED Company, Inc.
4. Kolbi Industries, Inc.
5. 3M Co.
6. Seton Name Plate Corp.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. Designate all equipment and valves by distinguishing numbers and letters on charts and/or diagrams.

1. Tag and locate following equipment items:

a. Valves.
b. All items indicated on drawing equipment schedules.

B. Install tags on all devices with numbers and letters corresponding to charts.

C. Fasten tags securely to devices with tag fasteners in manner for easy reading.

D. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, and control panels.

1. Secure nameplates with self-tapping screws, or nuts and bolts.

E. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

F. Furnish 4 charts including device number, location (room number, department) and purpose.

1. Mount 1 chart in frame and secure on wall in location directed by Owner.
2. Include remaining 3 sets in "Operation and Maintenance Manuals."

G. Provide all devices located above ceilings with additional identification.

1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
2. Coordinate with Owner on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Soil, waste, and vent piping do not require color coded paint or bands.

B. Locate pipe markers as follows:

1. Next to each valve and fitting, except on plumbing fixtures and equipment.
2. At each branch or riser take-off.
3. At each passage through walls, floors, and ceilings.
4. At each pipe passage to underground.
5. On all horizontal pipe runs every 20 ft., at least once in each room and each story traversed by piping system.
6. Identify piping contents, flow direction, supply and return.

C. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 SERVICE ABBREVIATIONS

A. General

1. DCW Domestic Cold Water

2. DHW Domestic Hot Water Supply (140 degrees F)
3. DHWR Domestic Hot Water Recirculating
4. PD Pump Discharge -Sump Pump/Sewage Ejector
5. G Natural Gas

END OF SECTION 220553

SECTION 220561 - PREPARATION OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CLEANING AND PREPARATION FOR SERVICE

A. Flushing Mains. Immediately upon completion of the water distribution system, test valves to ensure their full opening. Flush the system as follows: Open valve and permit the flow to continue until the water runs clear. Repeat the operation at the next valve and proceed in order to the valve farthest from the source of supply. Use outlets in building to flush the upper ends of mains and service lines. During such flushing operation, the A/E may test the flows from valves and, before final acceptance of the work, make further tests of flows to ascertain that lines are clear.

B. Interior and Exterior Sterilization of Water Distribution System. After the water distribution system has been flushed, sterilize the system by the following or other, more rigid methods satisfactory to the A/E and the State and Local Plumbing Authorities.

1. Introduce chlorine or a solution of calcium or sodium hypochlorite, filling the lines slowly and applying the sterilizing agent at a rate of 50 parts per million of chlorine, as determined by residual chlorine tests at the ends of the lines. Open and close all valves and hydrants while chlorinating the system.
2. After sterilization agent has been applied for 24 hours, test for residual chlorine at the ends of the lines. If less than 25 ppm is indicated, repeat the sterilization process.
3. When tests show at least 25 ppm of residual chlorine, flush the system until all traces of the chemical are removed.

C. The Owner reserves the right to require testing of the water again at any time prior to final acceptance of the work and, if found bacteriologically unsafe, to require the Contractor to rechlorinate the system until the water is proven equal to that supplied by the public system.

3.2 SANITARY WASTE/VENT AND STORM DRAINAGE SYSTEMS

A. Test systems as recommended by Local and State Plumbing Inspection Authorities.

3.3 OPERATIONAL TEST

A. Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

1. Time, date, and duration of test.
2. Water pressure at the most remote and the highest fixtures.

3. Operation of each fixture and fixture trim.
4. Operation of each valve, hydrant, and faucet.
5. Pump suction and discharge pressures.
6. Temperature of each domestic hot water supply.
7. Operation of each floor and roof drain by flooding with water.
8. Operation of each vacuum breaker and backflow preventer.
9. Complete operation of each water pressure booster system (when applicable), including pump start pressure and stop pressure.

END OF SECTION 220561

SECTION 220593 - PLUMBING SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
1. Domestic Circulating water systems, Hot Water.

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Balance to within plus or minus 10% of set point of balancing valves or pumps.

E. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF PLUMBING CONTRACTOR’S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Clean strainers prior to balancing system.

C. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

D. Maintain accessibility to test locations and devices requiring adjustment.

E. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Plumbing Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Owner.

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the CM/Owner may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data including balancing valve location and gpm.
         2) All equipment nameplate information.
         3) AABC equipment data sheets.
         4) Pump curves.
         5) Temperature readings leaving water heater or thermostatic mixing valve and at recirculation pump.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.
   1. If requested, conduct tests of instruments in presence of Owner.

B. If requested, conduct balancing tests in presence of Owner.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 WATER BALANCE PROCEDURE

A. Open all valves to full open position.

B. Checks pump rotation.

C. Check expansion tanks to determine they are not air-bound.

D. Check for installation and proper operation of manual air vents.

E. Check hot water supply temperatures and return water temperatures at mains. Reset to correct design temperatures.

F. After completing balancing valve to set points noted on drawings, test hot water pressures and flows at the pumps and re-adjust if required.

G. Check the following in domestic hot water systems.
1. Leaving water temperature at water heater.
2. Leaving water temperature at thermostatic mixing valve.
3. Pressure of domestic cold water at water service entrance.
4. Pump operating suction and discharge pressures and final total dynamic head.
5. Water metering device readings.

H. List all mechanical specifications of pumps.

I. Record nameplate and actual operating amperages of pump motor.

3.3 SPARE PARTS

A. Provide portable readout kit and specific manufacturer's balancing wheel (charts) for Owner's use.

3.4 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours' duration for domestic hot water systems to demonstrate to satisfaction of the Owner that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 220593

SECTION 220700 PLUMBING INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to;

1. Pipe insulation.
2. Equipment insulation.
3. Insulation adhesives, mastics and caulking.

B. Definitions

1. Concealed Insulated Surfaces: Piping and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, sealed alleyways, and above suspended ceilings.
2. Exposed Insulated Surfaces: Piping and equipment located in mechanical rooms, tunnels, and rooms without suspended ceilings.

1.3 QUALITY ASSURANCE

A. Comply with fire and smoke hazard ratings indicated.

1. Test by procedure ASTM E84, NFPA 255, and UL 723.
2. Accessories such as adhesives, mastics, cements, tapes, and glass fabric, same or better component ratings.
3. Following are rating requirements:

   a. Flame spread (maximum): 25
   b. Smoke developed (maximum): 50

4. Properly identify products and/or their shipping cartons for flame and smoke ratings.
5. Where prohibited by code or local ordinances, do not use elastomeric-type insulation anywhere within ceiling plenum return air systems.

1.4 SUBMITTALS

A. Shop Drawings: Submit schedule indicating service, application, thickness and finishes.

B. Product Data

1. Manufacturer's cut sheets and literature.
2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Close-Out Information

1. Manufacturer's installation, maintenance, and painting data.
2. Guarantees.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass Fiber Pipe Covering, Calcium Silicate, and Thermal Insulating Wool: Manville, Owens-Corning, Manson, Knauf.

B. Fire-Retardant Adhesive: Manville, Benjamin Foster, 3M, Insul-Coustic, Childers.

C. Lagging Adhesive: Manville, Benjamin Foster, Borden, Insul-Coustic.

D. Elastomeric Pipe Insulation and Equipment Covering: Armstrong Armaflex, IMCOA, Imcolock, Ultrafoam.

E. Insulated Fitting Covers: Manville, Certain-Teed, Knauf.

F. Insulation Caulking: Dow No. 11.

2.2 GENERAL

A. Provide fire and smoke hazard ratings as indicated for entire composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation).

B. Do not use material that exceeds specified flame and smoke ratings.

C. Use permanent treatments to jackets or facings to impart specified fire ratings.

D. Use of water soluble treatments is prohibited.

E. At Hangers and Bracing: See Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.

2.3 PIPE INSULATION, NON-FLEXIBLE

A. Pipe Insulation, Non-flexible

1. O-C fiberglas ASJ/SSL-II pipe insulation with all service jacket (ASJ).
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
3. Apply to the following piping in thickness indicated:

a. (Domestic) potable & non-potable cold water:

1) Runouts to fixture (<12 feet).....…….....1/2 inch
2) 1-1/4 inch and smaller.....…….....1/2 inch
3) 1-1/2 and larger.....…….....1 inch

b. Domestic hot/recirculating water (thru 140 deg F):

1) 1-1/4 inch and smaller…….. 1 inch
2) 1-1/2 inch and larger……....1-1/2 inch

c. Domestic hot/recirculating water (141 deg F thru 160 deg F):

1) 1-1/4 inch and smaller.....……1-1/2 inch
2) 1-1/2 inch and larger.....……2 inch

d. Domestic hot water with temperature maintenance cable (thru 140 deg F):

1) 1 inch and smaller.....……1 inch
2) 1-1/4 inch thru 1-1/2 inch.....……1-1/2 inch
3) 2 inch and larger.....……2 inch
4) 2-1/2 inch……..2-1/2 inch
5) 3 inch…… 3 inch

e. Horizontal rain leaders (including 24 inch up and down from horizontal and up to underside of roof deck):

1) All sizes.....…….....1 inch

2.4 PIPE INSULATION, FLEXIBLE

A. Pipe Insulation, Flexible

1. Armstrong self-seal AP Armaflex flexible elastomeric pipe insulation.
2. Thermal conductivity (K value): Not greater than 0.27 at mean temperature of 75 deg F.
3. Apply to following piping in thickness indicated:

a. Domestic (potable) cold water:

1) 2 inch and smaller.....…….....1/2 inch

b. Waste piping from water coolers and drinking fountains:

1) All sizes.....……..1/2 inch

c. Waste piping from lab sinks to main stacks:

1) All sizes.....…….1/2 inch

2.5 INSULATION FOR HOT EQUIPMENT

A. Insulation For Hot Equipment (Domestic Water Systems)

1. O-C Type 703 fiberglass board, 3.0 pcf, FRK facing.
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.

3. Apply to following equipment in 2 inch thickness:
    a. Domestic hot water instantaneous heaters

2.6 INSULATION FOR DOMESTIC WATER HEATER STORAGE TANKS

A. Insulation for Domestic Water Heater Storage Tanks

1. O-C Type 703 fiberglass board, 2 inch thickness, 3.0 pcf density, unfaced.
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75deg F.
3. Apply to all domestic water heater storage tanks, except when specified as factory-insulated.

2.7 INSULATION FOR COLD EQUIPMENT

A. Insulation for Cold Equipment

1. Armstrong Armaflex II sheet insulation; 1-1/2 inch material installed in 2 layers with joints staggered.
2. Thermal conductivity (K value): Not greater than 0.27 at mean temperature of 75 deg F.
3. Apply to following equipment in thickness indicated:

    a. Domestic water meter.....…….....3/4 inch
    b. Roof drain bodies.....……3/4 inch
    c. Water softeners.....……..3/4 inch

2.8 INSULATION FASTENERS

A. Insulation Adhesive: Childers CP-82.

B. Insulation Mastic: Childers CP-30.

C. Insulation Caulking: Dow No. 11.

PART 3 - EXECUTION

3.1 APPLICATION - GENERAL

A. Do not insulate piping until satisfactory completion of required pressure tests.

B. Do not insulate heat-traced piping until cable installation is complete and a megohmeter test has been passed.

C. Apply insulation to clean, dry surfaces with pipe surfaces at room temperature.

D. Butt insulation firmly together with longitudinal and end joints sealed with compatible jackets, facings and adhesives as specified.

E. Apply adhesives, mastics and coatings per manufacturer's recommendations and as specified.

F. On cold surfaces where vapor barrier jackets are used, apply insulation with a continuous, unbroken vapor seal.

1. Adequately insulate and vapor seal hangers, supports, and anchors that are secured directly to cold surfaces to prevent condensation.

G. Continue insulation through sleeves and wall and ceiling openings except insulation shall not continue through fire-rated (2-hour or greater) partitions, walls, floor-ceiling systems.

H. Insulate all fittings, valve bodies, flanges and other pipeline accessories.

I. At hangers and bracing, install in accord with Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.

J. Contractors shall consult manufacturer's Technical Bulletins for detailed information on safety precautions in using all insulation products, polyurethanes, polyisocyanurates, and related materials. The data shall describe fire and other risks, safety in handling, toxicity, threshold limit values, physiological effects of inhalation and eye and skin contact, incompatibilities and other essential information regarding use. Obtain six (6) copies for distribution and use at jobsite and for submittal with shop drawing submittals.

3.2 APPLICATION OF NON-FLEXIBLE PIPE INSULATION

A. On piping, install with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge on hot piping.

1. On cold piping, use self-sealing lap system or adhesive applied to both surfaces per manufacturer's recommendation.
2. Do not staple cold piping.
3. Butt adjoining sections of insulation tightly together and continue jacket by installing self-adhering butt strips over entire circumferential joint.

B. Installation of Insulation of Fittings

1. For pipe sizes 2 inches and smaller, finish with mineral fiber cement to thickness of adjoining pipe insulation.
2. Over 2 inches, insulate with mitered pipe insulation segments or preformed fiberglass fittings secured with vinyl faced insulation strapping tape or 20 ga galvanized annealed wire and finished with one coat of mineral fiber cement.
3. After cement is dry, finish with Glass Fab and seal with Foster 30-36 adhesive.
4. Prefabricated fitting covers approved for use at pipe fittings may be used instead of finishing method outlined above.
5. Install in accordance with manufacturer's recommendations.

C. Cover all insulated piping exposed to weather with additional jacket of 0.016-inch smooth aluminum with moisture barrier.

1. Apply aluminum jacket with 0.020-inch x 3/8-inch aluminum bands on 9-inch centers, minimum 2-inch lap joint.
2. Protect fittings, valves, and specialties exposed to weather in like manner.
3. Contractor option: Use Ceel-Co 300 Series plastic jacketing applied per manufacturer's recommendations.

D. Reinforce jackets on insulated piping in mechanical rooms and central plant less than 8 ft. above floor.

1. Cover with 0.030 inch PVC jacket conforming to 25-50 fire requirements.

3.3 APPLICATION OF FLEXIBLE PIPE INSULATION

A. Install tubing wherever possible by slipping material over piping. Otherwise, slit pipe insulation, tightly butt ends and seal butt joints and slit seams with suitable adhesive.

B. Insulate fittings and valve bodies with segments cut from pipe insulation. Apply with adhesive.

C. Insulate piping at hanger points with fiberglass material protected with metal saddles.

3.4 APPLICATION OF INSULATION ON HOT EQUIPMENT

A. Install insulation with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge.

B. Butt adjoining sections of insulating tightly together and continue jacket by installing self-adhering butt strips over entire joint.

C. Insulate flanges and fittings with mineral fiber cement.

D. Finish body with 0.016-inch aluminum jacket. Reinforce end and irregular surfaces with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.

3.5 APPLICATION OF INSULATION ON DOMESTIC WATER HEATER STORAGE TANKS WHEN TANKS NOT FACTORY-INSULATED

A. Install insulation with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge.

B. Butt adjoining sections of insulating tightly together and continue jacket by installing self-adhering butt strips over entire joint.

C. Insulate flanges and fittings with mineral fiber cement.

D. Finish body with 0.016-inch aluminum jacket. Reinforce end and irregular surfaces with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.

3.6 APPLICATION OF INSULATION ON COLD EQUIPMENT

A. Apply with Armstrong 520 adhesive covering entire surface as well as back of insulation.

B. Coat all butt edges and press firmly together with 1/8-inch overlay pressure.

C. Apply two (2) coats of Armstrong Armaflex finish over sheet surfaces.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. This Section applies to potable cold water, hot water, and hot water recirculation piping.

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by plumbing trade as required.

B. Wherever equipment is furnished and set in place under Work of another Section or by Owner, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.

1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
2. If the Owner does not provide information sufficiently in advance, the Owner shall provide compensation for additional costs incurred due to changes in location of required services.
3. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General

1. Provide all supervision, labor, tools, materials, equipment, accessories and specialties necessary to completely install, clean and test the plumbing systems.
2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the indicated purposes. All Work shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected; all Work shall be true to detail.

B. Codes and Standards (Division 22 Section “Common Work Results for Plumbing” Listings and the following).

1. Plumbing installation shall be in accordance with the state and local plumbing code, and all other codes having jurisdiction.
2. American Standard Code for Pressure Piping ANSI B31.1
3. National Association of Corrosion Engineers
4. American National Standards Institute (ANSI)
5. American Society of Mechanical Engineers (ASME)
6. American Society for Testing and Materials (ASTM)
7. American Water Works Association
8. Manufacturer's Standardization Society of the Valve and Fitting Industry
9. Plumbing and Drainage Institute
10. State or local Plumbing Code, as applicable.
11. State or local Building Code, as applicable.
12. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

C. Material Standards

1. ASTM B32-04: Specification for Solder, Metal Sizes.
2. ASTM B42-02: Specification for Seamless Copper Pipe, Standard Size.
3. ASTM B75-02: Specification for Seamless Copper Tube.
4. ASTM B88-03: Specification for Seamless Copper Water Tube.
5. ASTM B251-02: Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
6. ASTM B302-02: Specification for Threadless Copper Pipe.
7. ASTM A53-04a: Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
8. AWWA C651-05: Standard for Disinfecting Water Mains.

1.5 SUBMITTALS

A. Shop Drawings

1. Piping Systems: Submit piping layout drawings for domestic cold water, hot water, and hot water recirculation piping systems prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Valve Chart (See Division 22 Section “General Duty Valves for Plumbing Piping”)

a. Prepare valve chart for review prior to installation.

2. Test reports.
3. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General

1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
2. No extra cost shall be charged the Owner for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

1.7 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of piping as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

B. All uninsulated piping and fittings exposed to public view in kitchen and servery shall be chrome-plated or stainless steel. All piping and fittings in kitchen not exposed to public view shall be chrome-plated or painted with a high-temperature aluminum paint.

PART 2 - PRODUCTS

2.1 PIPING

A. General

1. The outside of all piping and fittings shall bear the Manufacturer's standard marking for type, pressure, etc.
2. The A/E does not guarantee the accuracy of the figure numbers as listed.
3. Use copper piping for domestic (potable) water system piping, except where noted on the Drawings to use CPVC piping.

B. Pipe - General

1. All pipe and fittings shall be equal to or better than the grade specified.
2. All piping material shall be new and free from defects and shall be subject to standard mill test before being shipped.
3. Pipe shall be labeled.
4. Fittings and valves shall have the Manufacturer's name or trademark legibly raised or cut into each piece.
5. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
6. No salvaged or used pipe shall be used without the written approval of the A/E or Owner. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.

C. Pipe 4-inch Size and Smaller

1. Pipe: Copper tube, seamless, type L hard temper, ASTM B-88, above ground, and type K soft temper, 2-inch and smaller, below ground.

    a. Fittings: Cast brass or wrought copper, solder type, ASTM 75, ANSI B16.22, or B16.18.
    b. Joints: Soldered, 95-5 tin-antimony solder above ground, and silver solder below ground.
        1) Within the clinic, use ProPress fittings.
    c. Unions: Sweat-end, 150 lb. cast brass, ground joint.
    d. Mechanically formed tee connections and couplings, such as T-drill, are acceptable. All joints shall be brazed with brazing material conforming to AWS A5.8 Classification BCUP-3 or BCUP-4.
    e. For 2-1/2-inch through 4-inch Type L copper piping above ground, the use of a grooved piping system including couplings, reducers, elbows, tees, and flange adaptors that are certified and approved by BOCA, IAMPMO, SBCCI, and UL for up to 300 psig working pressure and up to 230 deg F operating temperature is acceptable. All copper piping to be roll grooved.

2. Pipe: Stainless steel, Type 316, ASTM A312, aboveground, cold water only.

    a. Fittings: Stainless steel, Type 316.
    b. Joints: Welded autogenously or with approved filler material listed in ASTM A312 or mechanical joints in accordance with manufacturer’s instructions.
    c. Unions: Mechanical joint of the compression or mechanical sealing type, or dielectric fitting.

D. Pipe and Fittings 3-inch and Larger (Underground)
1. Ductile Iron Pipe

a. Pipe: Conform to AWWA C151.
b. Cement-mortar lining: Conform to AWWA C104.
c. Protective coating outside: Bitumastic or coal tar enamel.
d. Thickness class: 53.
e. Pressure class: 350 psi
f. Joints: Mechanical or push-on, conform to AWWA C111.
g. Fittings
    1) Gray iron or ductile iron
        a) Full-body: Conform to AWWA C110, or
        b) Compact: Conform to AWWA C153.
    2) Class
        a) 250 or 350 up to 24-inch diameter.
    3) Bituminous coating: Inside and outside.
    4) Cement lining: Conform to AWWA C104.
        a) Polyethylene encasement.
    5) Conform to AWWA C105.
    6) Thickness: 8 mil.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled. All auxiliaries and specialties shall be suitable for the piping to which they are attached.

B. Interior Hose Bibbs
1. Manufacturers:
    a. HB-1 & HB-2: Woodford, Prier, Crane, Nibco, or Red-White.
    b. HB-3: Nibco, Harvel, Spears.
2. HB-1: Woodford Model 24-P with 3/4-inch brass construction, wheel handle, teflon impregnated packing, threaded inlet (concealed supply).
3. HB-2: Woodford Model 24C with 3/4-inch brass construction, wheel handle, teflon impregnated packing, soldered inlet (exposed supply).
4. HB-3: Nibco 3/4-inch true union CPVC ball valve with male adaptor on outlet suitable for 3/4-inch hose connection.

C. Wall Hydrants
1. Manufacturers: Josam, J.R. Smith, Mifab, Wade, Woodford, or Zurn.
2. WH-1: Josam 71000 freezeproof faucet, bronze casing, hinged, locking polished bronze (nickel) box and cover, self-draining vacuum breaker, integral backflow preventer, 3/4-inch size. Length as required.
3. WH-2: Josam 71050 freezeproof faucet, bronze casing, (polished brass), nickel head with polished face, self-draining vacuum breaker, integral backflow preventer, 3/4-inch size. Length as required.

D. Hose Valves
1. Manufacturers:
    a. HV-1: Potter Roemer 4110 w/4615 Chain & Cap; Elkhart: Crocker Standard; or equal.
    b. HV-2: Nibco, Harvel, or Spears.
2. HV-1: 1-1/2-inch forged brass globe valve with red wheelhandle, femal N.P.T. inlet, and suitable for standard 1-1/2-inch hose thread connection on outlet. 1-1/2-inch cast brass cap with female hose thread, pin lugs, and chain.
3. HV-2: Nibco Chemetrol 1-1/2-inch true union CPVC ball valve with male adaptor on outlet suitable for 1-1/2-inch male hose connection.

E. Strainers

1. Manufacturers: Sarco, Anderson, Armstrong, Crane, or Watts.
2. Sarco type BT or BF-150, bronze body with stainless steel screen. Provide drain valve on strainer.

F. Water Hammer Arresters
1. Manufacturers: Josam, Mifab, Wade, J.R. Smith, Watts, or Zurn.
2. Josam type "Absorbatron".
3. Meet the requirements of PDI Standard WH-201 for size and location.
4. Size of unit shall be clearly indicated on unit.

G. Vacuum Breakers and Dual Checks
1. Manufacturers: Watts, Chicago Faucet, Febco, Wilkins, Conbraco, or Woodford.
2. Hose Connections: ASSE 1011, Watts #8A, 3/4-inch hose thread. (#8AC in finished areas).
3. Ice Machines: ASSE 1024, Watts Series 7 with two chrome nickel plated brass replaceable dual checks for 3/8 inch thru 1 inch size.
4. Coffee Maker: ASSE 1022, Watts SD-3 with stainless steel body, dual checks, wye strainer and drain port for 1/4 inch through 3/8 inch size. Pipe drain port to drain and terminate with air gap.

H. Backflow Preventers
1. Manufacturers: Watts, Conbraco, Febco, Wilkins, Ames, or Mifab, Beeco.
2. Pipes 1-1/2 inch and Smaller: ASSE 1013, Watts LF009 Series, all bronze, lead free, reduced-pressure-type with two ball valves. Provide strainer upstream.
3. Pipes 2 inch and Larger: ASSE 1013, Watts 957 Series, lead free, reduced-pressure-type with two check valves, pressure relief valve, and two ball (2 inch size) or gate valves. Provide strainer upstream.
4. Backflow preventers shall be serviceable without removal from pipe line.
5. Provide indirect drain with air gap fitting.

I. Trap Primer
1. Manufacturers: Josam, J.R. Smith, Wade, Zurn, Watts, Mifab, or E&S.
2. Mifab M-500 trap primer with M1-DU distribution unit as required.
3. Provide 1/2 inch soft type K copper pipe from the trap primer distribution devices to the trap primer inlet of the floor drains.
4. Trap primer shall require no greater than 3 psi to activate.

J. Trap Primer Manifold System
1. Precision Plumbing Products "Prime-Time" electronic trap priming manifold with atmospheric vacuum breaker, solenoid valve, water hammer arrestor, 3/4 inch copier manifold with 1/2 inch compression fitting taps, and 24-hour timer all installed in a 16 ga. steel enclosure with prime-coated access door and screwdriver door latch.
2. Provide 1/2 inch soft type "K" copper pipe from the trap primer distribution system to the trap primer inlet of the floor drains.
3. Electrical Contractor to provide 120 volt, one-phase, power to unit.
4. See noted data on Plans relating to locations of distribution systems and number of outlets required at each system.
5. Manufacturer: Precision Plumbing Products, Mifab, or Zurn.

K. Trap Seal Protection Devices
1. Subject to compliance with requirements, provide SureSeal Manufacturing; Inline Floor Drain Trap Sealer or approved equal.
2. Standard: ASSE 1072-2007
3. Body: ASB Plastic
4. Diaphragm & Sealing Gasket: Neoprene Rubber
5. Size: 2 inch (50 mm), 3 inch (75 mm), 4 inch (100 mm).
6. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

L. Domestic Water Valve Cabinet
1. 16 inch x 16 inch x 4 inch deep recessed cabinet with 1 inch flange all around flush with wall.
2. Cabinet shall be constructed of 18-gauge, 304 stainless steel with #3 polished finish.
3. Cabinet shall have continuously hinged door (gasketed) with keyed cam lock. Door shall be same construction as cabinet.
4. Cabinet to be as manufactured by Karp Associates, Inc., Milcor, Mifab, Wilconsin Co., or equal.

M. Drain Valves: Powell 502-HS with cap and chain, or equal by Hammond, Keystone, or Watts.

N. Gauge Cocks: Powell Fig. 757, or equal by Anvil, Waltec, Victaulic, White Rogers.

O. Hot Water Balancing Valves.
1. Manufacturers: Sarco W-SS-6, Flow Design Model (FDI) Model UA, Griswold or Tour Anderson (TA) Combination Balancing/Shut-Off.
2. Manual throttling venturi with union, chrome-plated ball, teflon seats, blowout-proof stem, adjustable memory stop, dual pressure and temperature ports, threaded or soldered connections, brass body, 600 psig at 205 deg F, ±3 percent accuracy.

P. Relief Valves
1. ASME tested and certified.
2. Shall have capacity to handle 100% of service.
3. Shall be set at 10% above the working pressure of equipment or service to which it is connected, or as noted.
4. Shall be iron body with stainless steel trim, renewable discs and seat rings, slow-opening-type.
5. Discharge shall be piped to nearest floor drain and arranged for safe discharge.
6. Manufacturers: Consolidated, Farris, Leslie, Lonergan, Manning-Maxwell-Moore.

Q. Temperature Regulators
1. ASME-coded.
2. Shall be pilot operated, of packless construction, for dead-end service.
3. Main valve shall be cast iron body, single-seated, with SECO metal seat, normally closed and guaranteed to shut tight.
4. Shall have an adjustable bi-metal thermostat, with a bronze or stainless steel bulb suitable for the application. Shall be complete with gages.
5. Shall be sized to meet the capacity and service indicated.
6. Shall be installed with strainer, shut-off valves.
7. Manufacturers: Spence Engineering Co., Fisher, A W Cash, McLear.

R. Temperature and Pressure Relief Valves
1. ASME-coded
2. All-bronze construction with seat-to-disc alignment that will not stick or freeze.
3. Shall start to open at 230 deg F and shall be fully open at 240 deg F.
4. Shall have snap action thermostat and sensing bulb sized to water heater Manufacturer's recommendations
5. Manufacturers: Watts, McDonnel, Wilkins, Conbraco.

PART 3 -

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Comply with Division 22 Section “Common Work Results for Plumbing”, as well as the requirements of Division 22 Sections “Hangers and Supports for Plumbing Piping, and “Plumbing Insulation”.

2. Piping shall be installed in a manner which permits easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.
9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed in a manner which does not cause pocketing or inhibit the flow of the material.
11. Install shut-off service valves with unions on all connections to equipment and on each side of control valves as required for ease of proper servicing and maintenance; see Division 22 Section "General Duty Valves for Plumbing Piping".
12. Unless otherwise indicated, the discharge from pressure-and temperature-relief valves and equipment drains shall be piped to the nearest floor drain, hub drain, or mop sink, installed with an approved air gap as required, and arranged for safe discharge.
13. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
14. Flanges and Gaskets
    a. Where forged steel flanges are to be bolted to cast iron flanges, a smooth or flat-face forged steel flange with a full-face gasket shall be used.
    b. All gaskets, other than teflon envelope or full-face, shall be of the flat ring type, with the outside diameter of the gasket extending to the edge of the bolts.
    c. Gaskets for all joints shall have an inside diameter equal to the outside diameter of the pipes on which they are to be used, to ensure that no portion of the gasket will project into the ports of valves, pipe, or fittings.
    d. The dimensions of all gaskets shall conform to ANSI Standard B-16.21 for non-metallic gaskets.
15. Dielectric Separation
    a. Provide dielectric separation at all copper piping and valves connected to ferrous piping.
    b. Brass or bronze valves installed in ferrous piping shall not require dielectric separation.
    c. Connections between copper piping and ferrous flanged piping and equipment connections shall be with a bronze companion flange with dielectric separation for flanges and bolts.
    d. Connections between copper piping and screwed ferrous piping shall be Clearflow Dielectric Waterway fittings.
16. Movement
    a. Mains: Provide adequate offsets, bends, loops, flexible joints and guides as required to prevent over-stressing of piping and/or the structure.
    b. Branches: Provide for expansion and contraction by means of offsets, swings, joints or loops to eliminate stress on connected piping, valves or equipment. Provide for proper drainage as required.
    c. Maintain a free floating, properly braced and supported piping system.

17. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

C. Painting of Piping: Refer to Division 09 Section “Interior Painting”.

3.2 SLEEVES

A. General
1. All sleeves shall be accurately located as required under this Division, and shall be properly sealed. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.
3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval from the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beam.

3.3 BUILDING PIPING SYSTEM: INSTALLATION

A. Domestic Water: Cold, Hot, Tempered, Recirculating
1. General
   a. All piping shall be installed and pitched to provide proper drainage.
   b. Install drain valves at all low points and as required to provide drainage facilities for the piping. Wherever system is sectionalized, install drain valves between each sectional shut-off valve.
   c. All hot water piping shall be pitched to provide natural gravity recirculation regardless of a recirculation pump.
   d. Install pressure gauge in domestic cold water main at water entrances to building.
2. Shock Elimination
   a. All piping shall be protected against water shock.
   b. Install a water hammer arrestor of the proper size at the end of the main, at the end of all branch lines, and at the end of lines serving groups of fixtures.
   c. Water hammer arrestors shall be sized and installed as recommended by the Plumbing and Drainage Institute, and shall eliminate water hammer.
   d. All water hammer arrestors shall be installed in locations where they are readily accessible for service. Where required, provide suitable access doors.
3. Contamination Protection
   a. All new distribution systems shall be protected against contamination due to backflow from non-potable sources.
   b. Provide an approved backflow preventer of the reduced pressure zone type at each connection to a fixture where indicated or required by code.
   c. Pipe to nearest floor drain.
4. Backflow Prevention

a. Install a code approved backflow preventer unit in the service main, where indicated on the Drawings, or as required by code.
b. Include strainer, dual-service shut-off valves, double-check valves, and check cocks.
c. Properly support, independent of the piping, with union connections.

5. Trap Primer
   a. All trap primers are to be located in an accessible area, preferably in mechanical rooms, janitor's closets, or accessible chases.
   b. Install trap primer so that, for every 20 feet of piping to floor drain inlet, the device is mounted one foot above the finished floor.
6. Water Meter
   a. Arrange for and pay all costs involved in the installation of a water meter in the building service line, where indicated.
   b. Support independent of the piping with union connections.
   c. Installation and meter shall be in accord with and approved by the water utility company.

END OF SECTION 22 11 16

SECTION 221123 - DOMESTIC WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. See Division 22 Section “Vibration and Seismic Controls for Plumbing Piping and Equipment”.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:

1. Furnishing all labor, materials, tools, equipment and services for domestic water pumps, as indicated, in accord with provisions of Contract Documents.
2. Complete coordination with work of all other trades.
3. Although such work is not specifically indicated, providing all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Description of Systems

1. Provide a complete building water pressure booster system, including all pumps, starters, disconnects, overload protection, pilot lights, control console, alarms, sensors, and accessories as required for a complete operable and code-approved system.
2. The control panel shall consist of the logic circuitry for sequencing three pumps - "A" led pump, as well as "B" lag pumps. The control panel shall also contain the power control (PC) circuit components for the booster pumps.
3. The PC shall be programmed to sequence the pumps according to the flow demand of the system.

1.3 QUALITY ASSURANCE

A. Standards

1. ANSI/HI Pump Standards.
2. Hydraulic Institute Engineering Data Handbook: HI990, Second Edition.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment item specified.

B. Product Data

1. Manufacturer's cut sheets for all components, equipment, etc. specified in this Section.
2. Performance data.
3. Pump curves.
4. Description of control panel with sequencing data and wiring diagrams.
5. System Drawings showing layout of components and piping, dimensions and field clearances.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Close-Out Information

1. Operating and maintenance data.
2. Guarantee.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Syncro Flo Inc, Systencon, Bell & Gossett, Squire Cogswell, Aurora, Peerless, Flo Pak, Canariis, or equivalent. Refer to Instructions to bidder, Article 2, for bidding of proposed equals.

2.2 Pumps, tanks, control panel and drives by same manufacturer.

2.3 DOMESTIC WATER PRESSURE BOOSTER SYSTEM

A. Pumps and Motors

1. Pumps shall be multi-staged end-suction design with cast iron bronze-fitted or stainless steel construction, equipped with sleeve-mounted mechanical shaft seals and close coupled to a high efficiency motor with class F insulation. Pump designs that do not have shaft sleeves shall not be acceptable. Pump shall be fitted with single inside mechanical seal with carbon vs. ceramic faces, stainless steel spring and hardware and Buna-N elastomers. Pumps shall be selected closest to the best efficiency point. Motors shall be non-overloading at duty point.
2. To protect the pump against overheating, provide a mechanical over-temperature protection device on the pump discharge that will divert flow to drain when water temperature exceeds 140 deg F.

B. Isolating Valves: Provide isolation valves on the suction and discharge of each pump. Valves shall be lug style butterfly valves with hand lever operator rated for a minimum 200psig W.P. Valves shall be certified to NSF 61 drinking water standards. Threaded gate valves and ball valves shall not be acceptable.

C. Check Valves: Provide a wafer style check valve to prevent back flow of water on each pump discharge. Check valve shall be manufactured from gray iron and shall be rated for a minimum of 200psig W.P. All contact surfaces shall be suitable for potable water service.

D. Pump Sequencing

1. The controller shall optimize power consumption based on flow, VFD speed, and power consumption. As a backup, a factory set pressure switch shall sequence pumps when system pressure falls below the setpoint. Automatic sequencing shall include the following features:

a. Flow sequencing. Package shall be furnished with a paddlewheel flow sensor factory mounted in a 3-inch diameter x 12-inch stainless steel spool piece with flanged connections.
b. Power sequencing, programmable in horsepower not Watts
c. Pressure sequencing .
d. End-of-curve protection, based on pump differential, with 2% accuracy
e. VFD speed sequencing
f. Lead pump shutdown feature that can be enabled or disabled by the operator
g. Low-flow test feature testing pressure, power, VFD speed, and flow (if equipped with flow sensor), to reduce pump short-cycling, pressure swings, power surges, and motor wear.
h.
i. Time clock to disable lead-pump shutdown during building occupancy.

j. Sequence shifting that adjusts the pump sequence when any pump is disabled
k. Successive and 24-hour alternation of equal capacity pumps
l. Pump overlap during 24-hour alternation
m. Lag pump exerciser function
n. Special sequencing to reduce surges during power restoration
o. Sequential sequencing of lag pumps
p. Minimum run and stop delay timer for each pump
q. Field adjustable time delay for lag pump pressure start signals
r. Field adjustable low suction pressure alarm
s. Field adjustable selection to enable / disable limited auto reset of low suction and high system pressure alarms

E. Power and Control Panel: Furnish a power and control panel in NEMA 1 enclosure complete with programmable controller, epoxy-coated backpan, operator interface, and 120V control circuit transformer. The complete assembly shall have the UL listing mark for industrial control panels. Provide circuit-breaker protection, not fuses that require replacement. The primary control power circuit breaker shall comply with UL file code 489 and the secondary circuit breaker with UL file code 1077. All components must conform to the IP10 finger safe design to protect against accidental contact. All internal power wiring must be 90° C rated per UL508A. Size power wire in accordance with UL508A Table 28.1. Control panel must meet 10,000 SCCR Rating.

F. Programmable Logic Controller: The PLC shall be installed on the control panel base pan, not the door, to protect it from damage. The PLC manufacturer shall be clearly marked on the controller, and non-proprietary. The PLC shall continue to function even if the touchscreen is broken, damaged, or removed. The PLC shall have the following features: 32,000 steps of built-in program memory, 7680 auxiliary relays, 320 timers, 235 counters, 8000 data registers, 24,000 extension registers, and 24,000 extension file registers

G. Variable Frequency Drives

1. Each pump shall have its own variable frequency drive with the following features:

a. Voltage source, GTR or IBGT power transistor based inverter - PWM Type
b. Use a high carrier frequency to reduce drive and motor noise
c. Shall be capable of operating in an ambient temperature between 15 degrees F and 100 degrees F and a line voltage variation of less than 10 percent.
d. Self-protection features shall include: under voltage and over voltage protection, current overload protection, short circuit protection, power failure protection, ground fault protection, and over-temperature protection.
e. Include a four-digit LED readout to indicate the following: drive enabled, output frequency, and all VFD fault conditions.
f. The drive shall automatically restart after any of the following: overload over-voltage, converter over-current, inverter over-current, or power failure.
g. The following drive parameters shall be user adjustable: acceleration speed (1 to 300 seconds), deceleration speed (1 to 300 seconds), minimum speed, and maximum speed.
h. The drive shall have a front mounted "HAND-OFF-AUTO" selector switch and a potentiometer for adjusting drive speed in the "HAND" position.
i. Minimum 1000,000 SCCR
j. The VFD shall use the following energy saving techniques:

1) Slows down the motor
2) Reduce current
3) Reduces voltage
4) Evaluates 6 motor characteristics to further increase efficiency.

k. The VFD shall communicate with the PLC with a DIGITAL connection, with the following capabilities:

1) Able to modify 300 different VFD parameters through the PLC and HMI
2) Read all VFD data and communicate it to the PLC, HMI, and write to the compact flash drive.

H. VFD Dust Protection: Install variable frequency drives smaller than 40 HP inside a NEMA 1 control panel, or provide dust protection to an externally-mounted drive. Provide fans to cool control panels with internally-mounted VFD's. Fans shall produce positive cabinet pressure, to prevent dust infiltration. Filter all incoming air.

I. System and Suction Pressure Transmitters: Mount the pressure transmitters inside the control panel. Digital pressure transmitters shall be connected to the suction and system headers. The transmitter shall have 1.0% accuracy, stainless steel wetted parts and a waterproof enclosure. Transmitter shall be IP67 rated, and capable of withstanding over pressurization of double its range. The transmitter shall use a digital 1-6 kHz pulse output that can be directly sent to a programmable logic controller (PLC) without requiring an additional analog module for measuring current. The transmitter zero set point must be capable of field calibration.

J. Instrumentation: Each system shall have pressure gauges for indicating suction and system discharge pressure, and control power light. All pump or header-mounted pressure gauges shall be 4-1/2 inch glycerin filled gauges. All panel mounted gauges shall be 2-1/2-inch glycerin filled gauges. Gauges shall have a stainless steel case and crimp ring, copper alloy movement with the case connection sealed with EPDM "O"-ring. Gauges shall be according to ASME B40.100, Grade A and shall have an accuracy of 1% of span.

K. Emergency Controls and Alarms: Furnish temperature relief valves at each pump, low suction, low system and high system pressure alarms, indication of first activated alarm, pulsing alarm horn with silence function, and individual alarm auxiliary contacts, time delays, and indicating lights. Provide backup sequencing and controls to provide temporary operation when the touchscreen or PLC is inoperable or removed.

L. Factory Prefabrication:

1. The system shall be factory prefabricated. Furnish flanged schedule 40 suction and discharge headers, which can be reversed in the field. All branch and header wetted parts shall be minimum 304 stainless steel. To minimize leak points, all branch and header connections shall be flanged or welded with the only threads located at the pump discharge. Secure all piping with adequate bracing and supports. The only field connections required will be to piping to system headers, tank, over-temperature drain tube, and one incoming power connection at the control panel.
2. All skid members must be properly designed structural steel, to adequately support the weight of the entire system, including piping and motors, and resist bending during transportation.

M. Factory Test and Certification: The booster system and its component parts shall undergo a complete operational flow test from zero to 100% design flow rate under the specified suction and net system pressure conditions. This flow test shall be performed by supplying the control panel with the specified incoming voltage. Each pump's performance shall be tested over its full range of flow. All adjustments shall be set and all functions verified. Components shall be tested for hydraulic shock, vibration, or excessive noise. Any parts found to be defective must be replaced prior to shipment. Full documentation shall be maintained by the manufacturer showing flow rates, pressures, and amp draws for future service and troubleshooting. In the Operation and Maintenance Manuals.

N. Field Piping: The contractor shall install the system adjacent to a floor drain sized in accordance with local code. This drain is to prevent building damage in the event of seal failure and to receive over-

temperature protection discharge. The contractor shall pipe the temperature relief valve discharge line to the drain. To reduce the possibility of damaging vibration, the contractor shall install the pump system on a flat housekeeping pad, bolted and grouted in place. The pump system shall be piped with a bypass and isolation valves, and with flexible connectors at the header connections.

O. Spare Parts: Each pump shall be furnished with a spare mechanical seal, shaft sleeve and gaskets.

PART 3 - EXECUTION

3.1 GUARANTEE

A. The pumping system shall be guaranteed in writing by the manufacturer for a period of 1 year from date of shipment against defect in design, material or construction.

3.2 START-UP SERVICE

A. The service of a factory-trained representative shall be made available on the job site to check installation and start-up and instruct operating personnel.

3.3 INSTALLATION

A. The complete installation shall be in accordance with the manufacturer’s instructions. The entire system shall be tested and adjusted under the authorized factory representative’s supervision.

B. Pumps shall be mounted on a concrete base. Entire package system shall be level and bolted to pad. Make final connection to system piping.

END OF SECTION 221123

SECTION 221316 - BUILDING SANITARY AND STORM DRAINAGE

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:

1. Provide a complete building storm water drainage system to 5 feet outside building exterior wall. Work includes, but is not limited to, the following:

a. Roof drains.
b. Floor drains.
c. Pipe materials.
d. Expansion joints.
e. Clean-outs.

2. Provide a complete soil, waste, and vent piping system to 5 feet outside building exterior wall. Work includes, but is not limited to the following:

a. Equipment coordination when equipment or fixtures are supplied by others.
b. Pipe materials.
c. Piping auxiliaries/specialties.
d. Drains.
e. Clean-outs.

3. Grease Interceptor .

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by the plumbing trade as specified.

B. Wherever equipment is furnished and set in place under Work of another Section or by Owner, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.

1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
2. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General

1. Provide all supervision, labor, tools, materials, equipment, accessories and specialties necessary to completely install, clean and test the building sanitary and storm plumbing systems.

2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the purposes indicated. All Work shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected and shall be true to detail.

B. Codes and Standards (Division 22 Section "Common Work Results for Plumbing" Listings and the following.)

1. Plumbing installation shall be in accordance with the state and local plumbing code and all other codes having jurisdiction.
2. American Standard Code for Pressure Piping ANSI B31.1.
3. National Association of Corrosion Engineers.
4. American National Standards Institute (ANSI).
5. American Society of Mechanical Engineers (ASME).
6. American Society for Testing and Materials (ASTM).
7. American Water Works Association.
8. Manufacturer's Standardization Society of the Valve and Fitting Industry.
9. Plumbing and Drainage Institute.
10. State or local Plumbing Code, as applicable.
11. State or local Building Code, as applicable.

C. Material Standards

1. ASTM A74-04: Specifications for Cast Iron Soil Pipe and Fittings.
2. ASTM A53-04: Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
3. ASTM B306-02: Specifications for DWV Copper Pipe.
4. ASTM C564-03: Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
5. Cast Iron Soil Pipe Institute CISPI No. 301-90 and ASTM A888-04: Specification Data for Hubless Cast Iron Pipe Systems with No-Hub Pipe and Fittings.
6. Cast Iron Soil Pipe Institute CISPI No. 310-90: Specification for coupling for use in connection with no-hub cast iron soil pipe and fittings for sanitary and storm drain, waste, and vent piping applications.
7. ASTM C1053-00: Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (OWV) Application.
8. ANSI A112.21.1-91: Floor Drains.
9. ANSI A112.36.2M-1991 (R2002): Metallic Clean-Outs.
10. ANSI A112.1.2-04: Air Gaps in Plumbing Systems.
11. ANSI A112.21.2M-1983: Roof Drains.

1.5 SUBMITTALS

A. Shop Drawings

1. Piping Systems: Submit piping layout drawings for sanitary waste and vent and storm piping prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Test reports.

2. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General

1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
2. No extra cost shall be charged the Owner for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. General

1. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
2. No salvaged or used pipe shall be used without the written approval of the A/E or Owner. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.
3. All cast iron pipe and fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.

B. Buried Soil, Waste, and Vent Piping

1. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
2. Options

a. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.

C. Above-Ground Soil, Waste and Vent

1. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.
2. Options

a. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
b. ASTM A53 Schedule 40 galvanized steel pipe with cast iron screwed drainage fittings.
c. ASME A112.3.1 type 316L stainless steel drainage pipe and fittings, spigot, and socket joints with EDPM gaskets.

D. Indirect Waste and Drains Above Ground

1. ASTM B306 DWV copper tubing with DWV copper fittings.
2. Options

a. ASTM D2665 PVC-DWV plastic pipe, drainage fittings with solvent weld joints.
b. Same materials as soil, waste, and vent.

E. Sump Pump Discharges

1. ASTM A53 Schedule 40 galvanized steel with cast iron screwed drainage fittings shall be used to point of connection to a gravity storm line or terminating with air gap at plumbing fixture/equipment.
2. Options: ASTM B306 DWV copper tubing with DWV copper fittings.

F. Interior Buried Storm Piping

1. ASTM A74 cast iron service weight soil pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed.
2. Options
   a. CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.
   b. ASTM D1785 solid schedule 40 plastic pipe with ASTM D2665 drainage fittings and solvent welded joints.

G. Exterior Buried Storm Piping

1. ASTM A74 cast iron service weight soil pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasket or oakum-lead joints.
2. Options: ASTM D3034, Type PSM, polyvinyl chloride (PVC), SDR 35 for solvent cement or elastomeric joints. Fittings to conform to ASTM D2556.

   a. Joints with elastomeric seals (integral bell) shall conform to ASTM D3212. Gaskets shall conform to ASTM F477.
   b. Joints with solvent cement shall conform to requirements of ASTM D2885 and ASTM D2564.

H. Above Ground Storm Piping

1. CISPI 301 hubless cast iron pipe, as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with heavy duty 304 corrugated stainless steel couplings.
2. Options

   a. ASTM A74 service weight cast iron pipe, bitumastic-coated, bell and spigot joints, drainage fittings with ASTM C564 gasketed.
   b. ASTM A53 Schedule 40 galvanized steel pipe with cast iron screwed drainage fittings.
   c. ASTM A112.3.1 type 316L stainless steel drainage pipe and fittings, spigot and socket joints with EDPM gaskets.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled, and shall be suitable for the piping to which they are attached.

B. Air Gap Fitting

1. J.R. Smith Fig 3951, rough bronze or plain end with set screw, threaded inlet and threaded outlet, sizes as indicated.
2. Manufacturers: Mifab, Watts, Wade, or Zurn.

C. Vent Flashings

1. Furnish 6 lb. lead flashing for General Contractor installation.

2. Flashing shall extend 12 inches in all directions, sealed between roofing plies, extended up to end of vent and clamped with vandalproof vent cap.
3. Vents Thru Roof (VTR): Refer to Architectural Drawings for vent thru roof detail in EPDM roof.

D. Vandalproof Vent Cap

1. J.R. Smith Fig. 1748 cast iron with set screws.
2. Manufacturers: Josam, Mifab, Stoneman, Wade, or Zurn.

E. Storm and Sanitary Piping Hubless Cast Iron Couplings

1. Shield constructed of type 304 stainless steel meeting ASTM 240. Neoprene gaskets shall conform to ASTM C564.
2. Couplings shall have a minimum of 4 bands and be capable of tightening to 80 lbs. torque.
3. The use of sealant or adhesives on couplings is not permitted unless approved by the manufacturer.
4. Couplings shall be heavy duty in accordance with ASTM C1540.

F. Cast Iron No-hub Restraints

1. Cast iron no-hub horizontal pipe and fittings, larger than 4", shall be suitably braced to prevent horizontal movement. Install at every branch opening or change in direction by the use of braces, blocks and rods to prevent movement or joint separation. This bracing may be field fabricated or a manufactured system.
2. Holdrite 117 series or equal.

2.3 DRAINS

A. General

1. All drains installed in waterproofed slabs shall be provided with a flashing ring.
2. Install a 30-inch x 30-inch x 6 lb. lead flashing properly fastened to the flashing ring.
3. Cast Iron roof, area, and floor drain manufacturers: J.R. Smith, Josam, Kusel, Mifab, Wade, Watts and Zurn.
4. Corrosion resistant floor drain manufacture: Zurn, Enfield, Kusel, Orion, R&G Sloan, and Duriron.

B. Roof Drains

1. Refer to drain schedule on drawings.

C. Floor Drains

1. Refer to drain schedule on drawings.

2.4 CLEANOUTS

A. General

1. Capable of adjustment to match finish surface.

a. Be round.

2. All cover plates/plugs shall be permanently labeled to match the drain service.
3. For cast iron fittings
4. Cast Iron clean-out manufacturers: Josam, J.R. Smith, Mifab, Wade, Zurn, Watts
5. Corrosion-Resistant Clean-Out Manufacturer: Duriron.

B. Clean-Out Types

1. Floor Clean-Outs

a. Finished Floor and Tile Floor: J. R. Smith Fig. 4020, Duco cast iron body and frame with round adjustable scoriated nickel bronze top. Top Labeled Co. Provide nickel bronze carpet clamping frame with vandalproof screw in carpeted areas.
b. Unfinished Floor and Equipment Area Floor: J. R. Smith Fig. 4240, Duco cast iron body and frame with round adjustable scoriated cast iron top. Top Labeled Co.
c. Corrosion resistant: Provide Duriron clean-out plug with floor access housing.

1) Finished Floor and Tile Floor: Zurn ZN-1404-VP floor access housing. ABS body with round nickel bronze top. Top Labeled Co.
2) Unfinished Floor: Zurn Z-1404-VP floor access housing. ABS body with round Dura-coated cast iron top. Top Labeled Co.

d. Floor clean-outs shall not be installed in the clinic.

2. Wall Cleanouts

a. J. R. Smith Fig. 4422, Duco cast iron caulk ferrule with vast bronze taper thread plug and prime-coated steel shallow cover. Vandalproof screws.
b. Corrosion resistant: Provide Duriron plug. Provide with J.R. Smith Fig. 4720 wall access cover with frame, chrome-plated bronze. Vandalproof screws.
c. Wall cleanouts shall not be installed in waiting rooms or hallways of the clinic. Wall cleanouts in the clinic shall be chrome finished and located in areas in which are inconspicuous.

2.5 GREASE INTERCEPTOR

A. Schier Great Basin grease interceptor model # GB-500 shall be lifetime guaranteed and made in USA of seamless, rotationally-molded polyethylene. Flow control cartridge shall be PVC. Interceptor shall be furnished for above or below grade installation. Interceptor shall be certified to ASME A112.14.3 (Type C) and CSA B481.1, with adjustable cover adapters, Safety Star® access restrictor built into each cover adapter, built-in flow control and three outlet options. Interceptor flow rate shall be 100 GPM. Interceptor grease capacity shall be 3,048 lbs. Cover shall provide water/ gas-tight seal and have minimum 16,000 lbs. load capacity. Interceptor shall be furnished with field cut riser model # FCR2 to enable access for below grade installation. Interceptor shall be furnished with pumpout port kit model #PP3 to enable remote pumpout.

B. Install components in accordance with manufacturer's instructions and approved product data submittals.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General

1. Comply with Division 22 Section “Common Work Results for Plumbing”.
2. Piping shall be installed in a manner to permit easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.

6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.
9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed not to cause pocketing or inhibit the flow of the material.
11. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
12. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

3.2 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendices.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendices.

3.3 SLEEVES: INSTALLATION

A. General

1. All sleeves shall be accurately located as required under this Division. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.
3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval of the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beams.

3.4 FLASHINGS: INSTALLATION

A. General

1. All penetrations of roofs and similar areas required for installation of vents, roof drains, and piping under this Division shall be properly flashed and made watertight.
2. Coordinate with all necessary General Trades Work sufficiently in advance and install in conjunction with roofing installation.

B. Flashing of Vent and Soil Pipe Extensions: All vent and soil pipe extensions through roof shall be minimum 3-inch size and flashed with 6 lb. sheet lead or 16 oz copper, 24-inch square, with sleeve soldered on, extending to top of pipe and turned down 2-inch inside.

C. Flashing of Roof Drains: All roof drains shall be flashed with 6 lb. sheet lead extending 12 inches from outer edge of drain opening.

D. Flashing of Curbs

1. Curbs shall be flashed under the General Trades Divisions of this Specification.
2. Provide counterflashing as required for weathertight construction.

3.5 BUILDING DRAINAGE SYSTEM: INSTALLATION

A. General

1. All storm and sanitary lines shall be of the sizes noted and routed as indicated.
2. Unless otherwise indicated or required by codes, all building drains shall be installed with a minimum uniform grade of one percent (1%).

3. No underground drains shall be installed in water. Trenches shall be dry and acceptable before laying of pipe.
4. All overhead lines shall be installed as close to the building structure as possible.
5. All overhead cast iron drains shall be supported at each joint, each change of directions, each cast iron trap, and all necessary intermediate points to maintain a uniform pitch without sagging or pocketing of the line.

B. Floor Drains

1. Install floor drains with lead flashing in waterproof floors per manufacturer's recommendations.
2. Install floor drains 1/2-inch lower than finished floor elevations to ensure positive drainage. Coordinate installation closely with General Contractor.

C. Cleanouts

1. Install at each of the following points, but not limited to:

   a. Base of each soil and waste stack
   b. Base of interior storm downspouts
   c. Change of direction of 45 deg or greater in the building drains
   d. Inside where the drains leave the building
   e. Where a battery of wall hung water closets are installed, provide cleanout at end of sanitary line in wall.
   f. Where indicated
   g. Install on continuous runs of the drains at 100' intervals on the storm and sanitary.
   h. As directed by local code

2. Shall be connected to the main with long sweep or sanitary wye fittings, unless otherwise noted.
3. Shall be installed to match the finished surface line.
4. Removable plugs shall be lubricated with a mixture of grease and graphite.

D. Traps

1. Install on all floor drains, all waste and soil discharge connections, and where indicated. Locate for ease of service. Any other traps required by official bodies having jurisdiction shall be installed at no additional cost to the Owner.
2. Where traps on plumbing fixtures are installed below grade or otherwise concealed, a clean-out shall be installed in the adjacent finished surface as indicated.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping[**, except outside leaders,**] on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

Prepare reports for tests and required corrective action.

END OF SECTION 221313

SECTION 221331 - ELEVATOR SUMP PUMP

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Elevator sump pump.

1.3 QUALITY ASSURANCE

A. General

   1. Provide all equipment as necessary for a complete installation of the Plumbing Systems.
   2. Receptacle and associated wiring shall be provided by the Electrical Contractor.
   3. The complete installation shall be in accordance with all applicable state and local codes.

1.4 SUBMITTALS

A. Shop Drawings: Submit shop drawings of all products in this section.

B. Product Data

   1. Manufacturer's cut sheets and literature.
   2. Performance data.
   3. Pump curves.
   4. Wiring diagrams for control panels.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Close-Out

   1. Operating and maintenance information.
   2. Owner instruction report.
   3. Guarantees and warranties.

PART 2 - PRODUCTS

2.1 ELEVATOR SUMP PUMP

A. Pump shall be capable of pumping storm water. Pump shall be equipped with hermetically sealed, Class F insulated motor, installed in a heavy ribbed cast iron shell. Refer to pump schedule on drawings.

B. Pump construction to include single mechanical seal. The motor shell and pump volute shall be made of close grained cast iron. Pump shaft shall be stainless steel and all fastening hardware shall be stainless

steel. The pump impeller shall be bronze closed type, accurately machined to the proper diameter, and dynamically balanced prior to installation in the pump. The impeller shall be non-overloading throughout the entire range of the pump curve. Pump and motor unit to receive a coat of red chromate primer and finish coat of water resistant metallic blue enamel.

C. Integral mechanical float type liquid level control shall be furnished for proper pump operation.

D. Manufacturers: Zoeller, Weil, Liberty, or equivalent.

2.2 PUMP CONTROLLER

A. Supply one UL listed - NEMA 1 or 4X steel simplex control panel suitable for wall mounting. Panel shall be completely factory wired and bench tested for satisfactory operation prior to shipment. The pump controller shall include oil detection circuitry which will shut down the pump, sound an alarm and energize a dry contact if a hydrocarbon is present in water in the sump pit. The following features will be included in the controller:

1. Properly sized NEMA rated starter pump.
2. High water alarm with light and silencing switch.
3. Main fused disconnect switch.
4. Circuit breaker.
5. Oil detection circuitry with alarm and silence switch.
6. Dry contacts for remote alarm monitoring for the following:

    a. High water alarm.
    b. Oil detection alarm.

2.3 OPERATING CONTROLS

A. Mercury float type liquid level controls shall be furnished for proper pump and alarm operation. Supply an oil sensor to detect hydrocarbons in the sump and disable the pump.

B. Three mercury switches, each sealed in a corrosion resistant polypropylene float shall be provided. Each switch to have a PVC coated UL listed cable and to be attached to a corrosive-resistant bracket to a stainless steel suspension rod. The switch bracket to be provided with a reinforcing sleeve to prevent sharp bending and damage to the cable.

C. One oil sensor, containing an infrared LED and a light receiver. Continuous light from the LED is directed into a prism, which forms the tip of the sensor. Two probes extend from the prism which measure conductivity to detect oil in the water and shut the pump down.

2.4 FIBERGLASS BASIN

A. Supply a fiberglass basin 24 inch ID x 3-foot depth, constructed of resin reinforced with not less than 20 percent glass strands.

B. Cover plate shall be minimum 1/4-inch-thick perforated and painted steel with necessary openings for pump discharge, power and control cables.

C. Manufacturers: Jackel, Topp Industries, Weil.

2.5 VALVES

A. Bronze check valve shall be installed on the pump discharge.

B. A Bronze shutoff valve shall be installed on the pump discharge.

2.6 WARRANTY

A. Warranty time shall be one-year from start up. Warranty shall extend to material and workmanship of the complete system.

PART 3 - EXECUTION

3.1 EXECUTION

A. See additional details and diagrams on the project drawing documents.

B. The complete installation of all items of equipment shall be in accordance with the Manufacturer's instructions. The entire system shall be tested and adjusted under actual operating conditions.

C. These pumps are not to be used during construction.

D. Flush all incoming lines to the pump basin and thoroughly clean the basin prior to placing pumps into operation.

E. A representative of the manufacturer shall be present during the pump start-up and shall completely check the pump system prior to the placing of pumps into operation.

3.2 START-UP

A. The pump manufacturer shall provide a technician for one (1) day start-up of the complete system, to insure ample time to make corrections and/or repairs. Start-up will consist of but not limited to the following:

1. Start-up and run of pump
2. Check all electrical devices
3. Provide a start-up report to the contractor, within 48 hours from start-up date for review and corrections if needed.

END OF SECTION 221331

SECTION 222000 - FACILITY NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades before fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of piping as may be required to meet the applicable job conditions. Coordinate with and review all related drawings of all trades before starting work.

1.3 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

PART 2 - PRODUCTS

2.1 PIPING

A. Below-ground pipe 5 feet from the building to above-ground at the building shall be Schedule 40 welded-joint steel pipe with factory-applied protective coating, such as X-Trucote. Joints shall be field-coated with the same material applied as recommended by the manufacturer. If under ground gas distribution pipe is steel, provide a dielectric union at point of connection. Install a 17-pound anode pack between the building and 5 feet outside the building next to the connection to the main service pipe. Attach the anode lead wire to the piping by means of an exothermic weld, following the instructions of the manufacturer.

B. Above-Ground Pipe, Fittings and Joints (Under 1 psig)

1. 2 Inches and Smaller

a. Pipe: ASTM A53, Type F, Schedule 40, carbon steel.
b. Fittings: ASTM A197/ANSI B16.3 Class 150, black malleable iron, threaded.
c. Joints: Threaded.

2. 2-1/2 Inches and Larger

a. Pipe: ASTM A53, Grade B, Type E or S, Schedule 40, carbon steel.
b. Fittings: ASTM A234 Grade WPB/ANSI B16.9, Schedule 40, seamless, carbon steel, welded.
c. Joints: Welded.

C. Above Ground Pipe, Fittings and Joints (Over 1 psig)

1. 2 Inches and Smaller

    a. Pipe: ASTM A106, Type B, Schedule 40, carbon steel.
    b. Fittings: ASTM A105/ANSI B16.11, 3000 pound forged steel, socket weld.
    c. Joints: Welded.

2. 2-1/2 Inches and Larger

    a. Pipe: ASTM A53, Grade B, Type E or S, Schedule 40, carbon steel.
    b. Fittings: ASTM A234 Grade WPB/ANSI B16.9, Schedule 40, seamless, carbon steel, welded.
    c. Joints: Welded.

D. Unions

1. 2 Inches and Smaller

    a. Malleable iron, ground brass seat, 150 psi steam working pressure; Stockham Figure 604 or equivalent.
    b. Forged steel, spiral wound gasket seats, ASTM A105, ANSI B16.5.

2. 2-1/2 Inches and Larger

    a. ANSI 150 pound class forged steel flanges, ASTM A105/ANSI B16.5. Standard bolt pattern, ANSI 150 pound class 1/8-inch thick gasket, Type 304 stainless steel, spiral wound metal with graphite filler.

3. The union of the underground coating and above-ground paint shall be at least 2 inches above finished grade and shall be well-bonded by application of the coating materials.

E. Corrugated, Stainless-Steel Tubing (CSST): Comply with ANSI/IAS LC 1. (To be used in corrosive environments)

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. OmegaFlex, Inc.
    b. Parker Hannifin Corporation; Parflex Division.
    c. Titeflex.
    d. Tru-Flex Metal Hose Corp.
    e. Gastite.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

    a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Operating-Pressure Rating: 5 psig

F. Gas piping within the building shall be electrically continuous and bonded to a grounding electrode.

2.2 ACCESSORIES

A. Shut-Off Valves

1. Plug Valves: Rockwell Nordstrom lubricated plug, Fig. 114 or 115 (regular pattern), or Fig. 142 or 143 (short pattern), or equal by A.Y. McDonald, Mueller Co., or Homestead Valve. Cast iron body, bronze plug, 125 psig rated, MSS SP-78, square or lug type operator, and suitable for natural gas service.
2. Ball Valves: Valves to be as manufactured by Conbraco Industries, A.Y. McDonald, or Perfection Corp. Bronze body, chrome-plated bronze ball, 2-piece, full port, 600 psi, CWP rating, MSS SP-110, and Suitable for natural gas service.

B. Gas pressure regulators shall be as manufactured by Equimeter, Spence or Fisher. Regulator shall have cast iron body, die-cast aluminum alloy diaphragm case and aluminum or brass orifices. Spring shall be adjustable and selected for an outlet pressure as indicated on Drawings, or 7-inch to 14-inch W.C. at equipment when pressures are not indicated on Drawings.

1. Properly vent gas pressure regulators to the outdoor atmosphere with screened vent caps.

C. Provide Grinnell Figure 13 or Figure 2, Fee and Mason or Crane nickel-plated steel plates on exposed pipes passing through walls, ceilings, floors, and partitions.

D. Provide serrated nozzle outlets, of type noted on the drawings, as manufactured by T&S Brass, Chicago Faucet, Water Saver or Royal Brass. Outlets shall have ground-key low pressure gas cock with integral serrated hose nozzle and chrome-plated finish lever handle and indexed for gas. Provide with escutcheon for wall mounting and turret for counter mounting. Basis of design: Wall mounted - T&S Brass model BL-4250-01; Single countertop mounted with turret – T&S Brass model BL-4200-01; Dual countertop mounted with turret and hose cocks at 180 deg – T&S Brass model BL-4200-02.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Gas piping system installation shall conform to the Standard for the Installation of Gas Appliances and Gas Piping USA Z21.30, ANSI Z106.1, NFPA No. 54 and No. 58, the rules of local and state regulatory agencies governing the installation of gas piping, the Gas Utility Energy Code for indirect gas service, and local gas utility company.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Concealed Locations: Except as specified below, install gas piping (in masonry walls) in an airtight conduit constructed of Schedule 40 seamless black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum. Valves shall not be located in such spaces. Piping in plenums shall be welded.
2. In Floors: Piping installed in floors shall have protective wrapping specified in PART 2 above. Piping cast in concrete slabs shall be surrounded with a minimum of 1-1/2 inches of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Piping shall not be embedded in concrete slabs containing quick-set additives or cinder aggregate. Piping shall be welded.
3. Piping in Partitions: Concealed piping shall not be located in solid partitions.
4. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.

D. Sleeves

1. Set sleeves during construction of walls, floors and foundations.
2. If a hole is required after the structure is cast, its location and size shall be approved by the A/E. Core-drill the hole. Maintain the fire integrity of the structure.
3. Where pipes pass through building construction, use proper length and gauge pipe sleeves of galvanized steel. Anchor sleeves to building construction. Size anchors to permit passage of insulation where insulation is required. Maintain the fire integrity of walls, floors, ceilings, and partitions.
4. Where pipes pass through foundation walls and footings, provide cast iron sleeve and caulk the space between sleeve and pipe with lead wool, watertight.
5. Install sleeves in floors perfectly plumb and in walls level. Center the pipe in the sleeve. Pack sleeves with fire-rated materials, per shop-drawing-approved submittals, and caulk in tight.
6. Extend floor sleeves only 3/8 inch to 1/2 inch above finished floors. Neatly level tops of sleeves.
7. Finish wall and partition sleeves flush with wall lines.

E. Seal pipe penetrations of fire barriers using fire barrier penetration sealers specified in Division 07 Section “Joint Sealants”.

F. Drips and Sediment Traps

1. Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.
2. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.
3. Drip legs at equipment connections shall be down stream of valve.

G. Use fittings for all changes in direction and all branch connections.

H. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

I. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

J. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

K. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

L. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

N. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

O. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

P. Conform to the table below for maximum spacing of supports:

Steel Pipe Size (NPS)	**Spacing in Feet**	**Min Rod Size Inches**
1/2	6	3/8
3/4 to 1-1/4	6	3/8
1-1/2 to 3 (horizontal)	12	1/2
3-1/2 to 5 all sizes (vertical)	Every floor level	

Q. Install unions in threaded pipes, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

R. Install dielectric unions where piping of dissimilar metals are joined.

S. Install flanges in welded piping, on valves, apparatus, and final connections to each piece of equipment.

T. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

U. All gas piping exposed to outside weather environment to be protected from corrosion by application of a non-metallic based painting system specifically designed and manufactured for protection of steel structures. Color as selected by Owner.

3.2 PIPE JOINT CONSTRUCTION

A. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.

B. Threaded Joints

1. Conform to ANSI B1.20.1, tapered pipe threads for field-cut threads. Join pipe, fittings, and valves as follows:

   a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.
   b. Align threads at point of assembly.
   c. Apply appropriate tape to thread compound to the external pipe threads.
   d. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
   e. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

3.3 VALVE APPLICATIONS

A. General: The drawings indicate valve types, locations, and arrangements.

B. Shut-off Duty: Use gas cocks specified in PART 2 above.

3.4 VALVE INSTALLATIONS

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Install a gas cock upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

C. Install pressure relief or pressure limiting devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Install gas cock upstream and within 6 feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.

B. Sediment Traps: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of 3 pipe diameters in length. Sediment shall be downstream of shut-off valve.

3.6 ELECTRICAL BONDING AND GROUNDING

A. Install above-ground portions of gas piping systems, upstream from equipment shut-off valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."

B. Do not use gas piping as a grounding electrode.

C. Conform to NFPA 70, National Electrical Code, for electrical connections between wiring and electrically-operated control devices.

3.7 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54 and local utility requirements.

END OF SECTION 222000

SECTION 223300 - DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
1. Gas-Fired water heater.
2. Recirculation pumps.
3. Thermostatic mixing valves.
4. Expansion tanks.
5. Accessories.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

1. Product data, including rated capacities of selected models, weights (shipping, installed and operating), furnished specialties, accessories, dimensions, required clearances, methods of assembly of components, piping and wiring connections.
2. Wiring diagrams from manufacturers, detailing electrical requirements for electric power supply wiring to water heaters. Include ladder-type diagrams for interlock and control wiring required for final installations of water heaters and controls. Differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.

1.4 QUALITY ASSURANCE

A. UL Standards: Provide water heater complying with the following:

1. UL 1453, Electric Booster and Commercial Storage Tank Water Heaters.

B. Electrical Component Standard: Provide components complying with NFPA 70, National Electric Code.

C. Listing and Labeling: Provide water heaters that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electric Code, Article 100.
2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

D. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90A, Energy Conservation in New Building Design.

1.5 WARRANTY

A. Special Project Warranty

1. Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but shall not be limited to, tanks. This warranty shall be in addition to, and a limitation of, rights the Owner may have against the Contractor under the Contract Documents.
2. Warranty period is 3 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GAS-FIRED WATER HEATER WITH STORAGE TANK

A. System shall be completely factory assembled and shall include a copper heat exchanger type hot water supply boiler. All waterways shall be copper, brass or bronze. Storage tank and hot water supply boiler shall be connected with all non-ferrous piping and shall be installed per manufacturer's recommendations. System shall include properly sized all bronze circulator, inlet and outlet thermometers, junction box, safety flow switch, tank temperature thermometer, ASME temperature and pressure relief valves, and tank temperature control. Electrical Contractor to provide 120 volt, 1 phase, power to boiler control panel and to circulating pump.

B. Storage Tank: Shall be of glass-lined design and shall be constructed in accordance with ASME code bearing the ASME symbol, and have a working pressure of 150 psi. Exterior of tank shall have heavy 16 gauge galvanized jacket and be finished with 3 coats of an acrylic enamel paint. Interior of tank shall be glass-lined with alkaline borosilicate composition, fused to the steel by firing at a temperature range of 1400 deg F to 1600 deg F. Glass coating shall be continuous over entire inner surface of tank. Cathodic protection shall be provided in tank. Jacketed storage tank shall have high density polyurethane foam or fiberglass insulation and meet ASHRAE 901b-1992 (1992 requirements). Provide tank with manhole, equipped with magnesium anode rods, temperature and pressure relief valves, and drain valve. The assembly is to be mounted on “I” beam skids.

C. Hot water supply boiler and storage tank shall have a 5 year limited warranty against corrosion.

D. Provide direct-air vertical venting kit as indicated on Mechanical Drawings.

E. Refer to Drawings for models, sizes and capacities.

F. Manufacturers: A.O. Smith, Raypak, Precision, Parker, Lochinvar, RBI, Laars, PVI.

2.2 RECIRCULATING PUMPS

A. In-line all lead-free bronze pump with gauge ports at nozzles and with vent and drain ports. Ceramic or carbon steel shaft supported by permanently lubricated carbon or steel bearings. Pump suitable for continuous operation at 230 deg F at 150 psi working pressure. Built-in overload protection. Motor shall be non-overloading at any point on the pump curve. Capacity and electrical characteristics as noted on the Drawings.

B. Manufacturers: Bell & Gossett, Grundfos, TACO, Armstrong.

2.3 THERMOSTATIC MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Armstrong International, Inc.
    b. Lawler Manufacturing Company, Inc.

c. Leonard Valve Company.
d. Powers; a division of Watts Water Technologies, Inc.
e. Symmons Industries, Inc.
f. Bradley Corp.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components. Lead-free design.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, wall mounting bracket, and adjustable temperature-control. Thermometer on outlet.
8. Tempered-Water Setting: As noted on Drawings.
9. Valve Finish: Rough bronze.
10. Refer to Drawings for design characteristics such as flow rate and pressure drop.

2.4 EXPANSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

1. Available Manufacturers

a. AMTROL Inc.
b. Armstrong Pumps, Inc.
c. Elbi of America, Inc.
d. Taco, Inc.
e. Watts Regulator Co.
f. Wessels Co.

2. Construction

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread. Include tap for pressure gauge.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.
d. ASME rated.

3. Capacity and Characteristics

a. Working-Pressure Rating: 150 psig.
b. Capacity Acceptable: Refer to Schedule on Drawings.
c. Air Precharge Pressure: Set air pressure equal to incoming water pressure downstream of water service backflow preventer.

2.5 WATER HEATER ACCESSORIES

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) WITH ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

D. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.

E. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

F. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

G. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

I. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Construct concrete equipment base.

B. Install reinforcing bars, tied to frame and place anchor bolts and sleeves using manufacturer's installation template.

C. Place concrete and allow to cure before installation of equipment.

3.2 WATER HEATER INSTALLATION

A. General: Install water heaters on 4-inch concrete bases. Set and connect units in accordance with manufacturer's written installations instructions. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections of Division 22. The drawings indicate general arrangement of piping, fittings and specialties. The following are specific connection requirements:

1. Install piping adjacent to equipment arranged to allow servicing and maintenance.
2. Connect hot and cold water piping to units with shut-off valves and unions. Extend relief valve discharge full-size to closest floor drain.

a. Where water heater piping connections are dissimilar metals, make connections with dielectric fittings or dielectric unions specified in Division 22 Section “Common Work Results for Plumbing”.
b. Install expansion tanks at cold water inlet piping as shown on drawings.

3. Install drain as indirect waste spill into open drain or over floor drain.

    a. Install drain valves at low point in water piping, for water heaters not having tank drain.

B. Electric Connections

1. Power wiring and disconnect switches area specified in Division 26.
2. Grounding: Connect unit components to ground in accordance with the National Electric Code.

3.4 FIELD QUALITY CONTROL

A. General

1. Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Owner's maintenance personnel as specified below.
2. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing and preventative maintenance.

1. Review data in Operating and Maintenance Manuals. Refer to Division 01 Section “Contract Close-Out”.
2. Schedule training with at least 7 days’ advance notice.

3.5 COMMISSIONING

A. Perform the following before start-up final checks:

1. Fill water heater with water.
2. Piping system test complete.
3. Check for pipe connection leaks.
4. Test operation of safety controls and devices.

B. Perform the following start-up procedures:

1. Energize circuits.
2. Adjust operating controls.
3. Adjust hot water outlet temperature setting.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:

1. Inclusion of all plumbing fixtures, complete and ready for use.

a. All fixtures, except as otherwise specified, shall be constructed of vitreous china with all visible exposed surfaces glazed.

2. Providing all stops, traps, escutcheons, connections, etc., as are necessary to complete the installation of each fixture, whether such items are listed or not.
3. Plumbing Trim

a. All finished exposed faucets, traps, connecting piping, stops, flush valves and other fixture trim shall be chromium-plated brass unless otherwise specified and shall be supported rigidly to fixtures and to walls with matching brackets at not more than 2'-0" center. All fastenings shall be chromium-plated brass or may be 302 stainless steel if of matching color and finish.
b. Faucets shall be furnished as required. All faucets shall be lead-free.
c. Vacuum breakers shall be provided as a part of the fixture trim wherever there is a possibility of back-siphoning.

4. Fixture Stops

a. Shut-offs for urinal and water closet flush valves shall be an integral part of the fixture or fitting; shut-offs for all other fixtures shall be loose-key, lock-shield-type.
b. All fixture stops shall be angle- or straight-type adapted for each particular location and shall be located immediately adjacent to the fixture. Use threaded adaptors when used in conjunction with copper tube work. All stop valves shall be lead-free

5. All exposed screws or fasteners for plumbing fixtures and faucets shall be vandalproof. Contractor shall take care to coordinate this item with his suppliers prior to Shop Drawings submittal.
6. Aerators, where required for sinks and lavatories shall be vandalproof.

1.3 QUALITY ASSURANCE

A. Meet the requirements of the following:

1. State Plumbing Code.
2. State Department of Housing, Buildings and Construction.
3. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

B. Material Standards

1. ANSI/ASME A112.19.2-2003: Vitreous China Plumbing Fixtures.
2. ANSI/ASME A112.19.3-2000 (R2004): Stainless Steel Plumbing Fixtures (Designed for Residential Use).
3. ANSI/ASME A112.19.4M-94: Porcelain Enameled Formed Steel Plumbing Fixtures.
4. ANSI/ASME A112.19.5-1999: Trim for Water Closet Bowls, Tanks, and Urinals.
5. ANSI/ASSE 1016-90: Performance Requirements for Thermostatic, Pressure Balancing and Combination Control Valves for Bathing Facilities.
6. ANSI/ASSE 1025-78: Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon-Type, Residential Applications.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Catalog cuts, including all fixture trim.

C. Samples: Not required for review.

D. Project Information: Not required for review.

E. Contract Close-Out Information

1. Operating and maintenance data.
2. Guarantees.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

A. Acceptable Manufacturers

1. Plumbing Faucets (Commercial Grade): Chicago Faucet, Delta, Moen, Powers, Symmons, Speakman, T&S Brass Co., Hydrotek
   a. Within the clinic, see schedule for manufacturer and model.
2. Flush Valves: Sloan, Delany, Zurn, and Hydrotek
   a. Within the clinic, see schedule for manufacturer and model.
3. Vitreous China Plumbing Fixtures: American Standard, Kohler, Eljer, Zurn.
   a. Within the clinic, see schedule for manufacturer and model.
4. Mop Sinks
   a. Terrazzo: Crane, Creative Industries, Fiat, Florestone, Stern and Williams.
   b. Molded Stone: Crane, Fiat, Florestone, Mustee, Swan Corp., Zurn.
5. Closet Seats: Church, Sperzel, Olsonite, Beneke, Centoco.
6. Stainless Steel Sinks: Elkay, Just, Metcraft, Southern Kitchens.
   a. Within the clinic, see schedule for manufacturer and model.
7. Electric Water Coolers: Elkay, Haws, Oasis, Halsey-Taylor.
8. Carriers: Josam, Mifab, Smith, Wade, Watts, Zurn.
9. Supply Stop Valves: Brasscraft, McGuire, Nibco, Watts.

B. Plumbing Fixtures – General: Constructed or equipped with anti-siphon devices to prevent siphoning waste material into potable water supply system.

C. Escutcheons and Plates: Conceal all holes where pipes pass through walls, floors or ceilings; use plates or escutcheons.

D. Piping Exposed in Finished Areas (including fittings and trim): Chromium-plated or nickel-plated brass with polished bright surface.

E. Trim for Lavatories and Sinks: Provide with renewable cartridges.

F. Vitreous Caps: Provide for water closet bolts.

G. Sealant: Silicone-type. See Division 7 Section “Joint Sealants”.

2.2 CHAIR CARRIERS

A. Carriers for Water Closets
1. Use cast iron couplings where required by Code.
2. Josam 12000 Series.

B. Carrier for Urinals: Josam 17800 or 17810.

C. Carriers for Lavatories: Josam 17100, 17100-76.

D. Carriers for Service Sinks: Josam 17720.

2.3 INSULATION AT HANDICAPPED (ADA-COMPLIANT) LAVATORIES

A. Insulation
1. Handicapped lavatories exposed waste, hot and cold water supply lines shall be insulated with a molded, flexible vinyl insulation system with all fasteners. Provide insulation for 1-1/4-inch waste offset drain, tailpiece, P-trap and waste arm and 3/8-inch supply tubing and 3/8-inch keyed stop valve. Color shall be white.
2. Manufacturers/Products

a. IPS Corp Truebro Lav-Guard 2.
b. Plumberex Pro-Extreme.
c. McGuire ProWrap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sink manufacturer shall provide proper template to architectural woodwork supplier for cutting of countertop.

B. Plumber shall place sink in countertop and complete faucet and piping.

C. Install all fixtures in accordance with Manufacturer's recommendations.

D. All fixture support carriers shall be of the type necessary to permit adjustment to fit variations in construction. All grounds or special supports necessary for setting fixtures shall be provided before plastering or other finished construction work is begun. All fixtures shall be hung at standard height unless otherwise indicated by the A/E.

E. Minimum fixture connection sizes are shown on the Drawings.

F. Provide chrome-plated brass escutcheons on all waste and supply piping penetrating the walls and floors for fixtures, including piping within cabinets.

G. Provide fixture carriers and required drainage fittings on all wall hung fixtures. Anchor carriers securely to floor.

H. Where plumbing fixtures abut to walls, floors, and countertops, seal all joints with sealant.

I. Seal floor sinks to wall and floor with building sealant. Color shall match fixture.

J. Provide anchors behind the wall for flush valve supply piping.

K. Adjust self-sustaining closet seats for proper operation and to sustain in any position.

L. Adjust electric water coolers flow for correct operation and temperature.

M. Insulate the hot and cold water and waste piping under handicapped lavatories.

N. After all fixtures have been set and are ready for use, and before the Contractor leaves the job, they shall thoroughly clean all fixtures furnished and set by them, removing all stickers, rust stains and any other matter or discoloration of fixtures, leaving every part in new condition. They shall, further, adjust all flush valves and other fixture water tempering or balancing at supplies to give proper water flow of fixtures.

END OF SECTION 224000

DIVISION 23

HVAC EQUIPMENT

HVAC AND CONTROLS INDEX

DIVISION 23 – HEATING, VENTILATION, AND AIR CONDITIONING

DIVISION 25 – CONTROLS

END OF HVAC AND CONTROLS INDEX

SECTION 23 0500

GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work under this Section includes, but is not limited to, providing all labor, material, equipment, and services necessary for completion of all mechanical systems in a serviceable fully operational manner.

B. All items of Work and systems shall be furnished and installed ready for satisfactory operation and all required apparatus and service shall be provided even if not specifically mentioned herein.

C. The Contract Specifications and Contract Drawing Equipment Schedules list the equipment manufacturers selected for the basis of the Specifications and for the various individual equipment layouts on the Contract Drawings. Substitutions shall be made in accordance with General Conditions and as otherwise provided in the Contract Documents.

D. The Drawings showing the layout, arrangements, sizes and principal connections to the equipment and apparatus are based on one particular type of equipment of an acceptable manufacturer. If equipment other than the particular type shown on the layout Drawings is used, it is the Contractor's sole responsibility to make all necessary modifications to related piping, ductwork, electrical and utility connections, apparatus and miscellaneous items to complete the Mechanical Work, ready for satisfactory operation required under these Specifications. The cost of making all the modifications shall be borne by this Contractor without extra cost to the Owner, Architect or Engineer. In using such equipment, it is imperative that the equipment must fit the space and the access allotted, with the final layout to be approved by the Architect/Engineer (A/E). Follow the Drawings as closely as actual building construction permits.

E. The Drawings show the principal engineering design elements of the mechanical installation. They are not intended as detailed construction installation drawings for the Mechanical Work but as a complement to the Specifications to clarify the principal features of the mechanical systems. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installation complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Contract Specifications or shown on the Contract Drawings.

F. Check the layout of the Work of this Division, as indicated on the Drawings. Determine exact locations by the dimensions of the equipment approved. Obtain written approval from the Engineer for any revised layout before equipment or material involved is installed. Consult the Architectural and Structural Drawings for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, swings of door, and other detail information required for a correct installation of this Work.

G. Examine all other Divisions of the Contract Documents for Work related to the Work of this Division. Cooperate to provide continuity of Work, to eliminate duplications, and to provide Mechanical Work in support of such related Work. Furnish to other trades and on schedule all information required for the execution of Mechanical Work.

H. Any additional Work such as cutting, drilling, patching, excavating, moving of another trade's work because of delay in Mechanical Work or lack of information is a part of this Division and shall be performed without increase in Contract Price.

I. Install and connect devices and equipment in accordance with the best engineering practice and the manufacturer's instructions and recommendations. Provide all incidental ductwork, piping, valves, connections, and all similar material recommended by the manufacturer, or required for proper operation and maintenance, complete without additional costs.

J. Provide all necessary rigging, scaffolding, tools, tackle, labor and other materials or equipment which may be necessary for the completion of the Work.

K. Furnish and install motor on proper frame designed by the equipment manufacturer.

L. All control wiring associated with the mechanical systems shall be provided under Division 23. All wiring shall comply with Division 26 Standards.

1.2 SPECIFIED ELSEWHERE

A. The following will be provided under other sections of the Specifications:
1. Openings: Walls, floor, ceiling, and roof opening specifically shown and identified on the Architectural/Structural Drawings will be provided under other Divisions. Openings not so identified that are required for Mechanical Work, or changes to such openings are part of the Work of this Mechanical Division.
2. Curbs, Drains and Sleeves: Drains and roof sleeves provided under this Division shall be incorporated into the finished roofing and made watertight under another Division.
3. Equipment Bases: Concrete equipment bases, mounting slabs, and housekeeping pads specifically shown and identified on the Mechanical Drawings shall be provided under this Division. Supervise their installation. Those bases, not so identified and indicated on the Architectural and Structural Drawings, shall be provided under other Divisions. Cooperate and furnish dimensions, sleeves, inserts, hold-down bolts, and templates for their installation.
4. Painting: Painting of all exposed-to-view pipes, ducts, hangers, supports, and equipment, shall be performed under another Division. Under this Division, all manufactured equipment shall be furnished with factory-finished baked enamel, unless otherwise specified.
5. All power wiring associated with equipment provided under this Division shall be furnished, installed, and wired in accordance with Division 26. Under Division 23, provide installation instructions, locating dimensions, and wiring diagrams for the other trades. Supervise the installation and start-up and test the equipment.

1.3 RELATED WORK

A. The Drawings, General Provisions of the Contract, General Conditions, General Requirements, Supplemental General Conditions and Division 01 through 26 all apply to the work in this Section.

1.4 DEFINITIONS

A. Provide: Furnish, install, and connect up complete and ready for operation of particular work referred to, unless specifically otherwise noted.

B. Furnish: To purchase, procure, acquire, and deliver complete with related accessories.

C. Install: To erect, mount and connect for use complete with related accessories.

D. Work: Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

E. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

F. Exposed: Not installed underground or concealed as defined above.

G. Accessible: Capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, ductwork or going through doors or false ceilings.

H. Words: Words used in the singular number shall include the plural sense and vice versa.

I. Wiring: Wire or cable installed in conduit, with all required boxes, fittings, supports, connections, etc.

J. Power Wiring: That wiring between the source of power and the current consuming device such as motors, equipment, heaters, etc. It includes the installation of such control devices in the power circuit such as pushbuttons, thermostats, key switches, timers, etc., which control loads for which no magnetic starter or contactor is provided for controls.

K. Control Wiring: That wiring between control devices that does not provide the power circuit, regardless of voltage, when a magnetic starter or contactor is provided for control.

1.5 INTENT

A. Furnish, erect, install, connect, clean, adjust, test and place in service all materials, equipment and systems in accordance with applicable codes, manufacturer’s directions and recommendations for all work shown on the drawings and called for in the Specifications.

B. Carefully examine the contract documents, visit the site, and thoroughly become familiar with the local conditions relating to the work. Failure to do so will not relieve the contractor from any obligations of the Contract.

C. Should there be any discrepancies of a question of intent, refer the matter to the Architect/Engineer for a final decision before ordering any equipment/materials or before starting any related work.

D. In case of conflict between project specifications and drawings, drawings govern unless the Architect/Engineer rules otherwise.

E. Apparatus, devices, materials of work not specifically shown on drawings, but mentioned in the project specifications, or vice versa, or any incidental accessories and appurtenances necessary to make the work complete and ready for operation, even though not specified or shown on the drawings, shall be furnished and installed without additional expense to the Owner.

F. It is the contractor's responsibility prior to bids to review all project documents.

G. Project documents include architectural, structural, mechanical, control, plumbing, fire protection and electrical disciplines.

1.6 CODES AND STANDARDS

A. Applicable Publications: Reference made herein to standards, Specifications, or codes, refer to the latest edition including all addenda, errata, or other revisions thereto, existing on the date of execution of the Contract.

B. Local Codes and Ordinances: Install all Work in conformance with all applicable local Codes and state ordinances and statues. Nothing in the Specifications or Drawings shall be construed to permit deviation from the governing codes. In case of conflict with local ordinances and statues, the more stringent shall apply.

C. Abbreviations: Refer to Division 01, Abbreviations and Symbols under Mechanical Sections make use of the following abbreviations in adopting applicable standards and codes as a part of Division 23:

1. ADC - Air Diffusion Council - Test Code
2. AGA - American Gas Association
3. AIA – American Institute of Architects
4. AMCA - Air Moving and Conditioning Association
5. ANSI - American National Standards Institute
6. API - American Petroleum Institute
7. ARI - Air Conditioning and Refrigeration Institute
8. AGA - American Gas Association
9. ASHRAE–American Society of Heating, Refrigeration and Air Conditioning Engineers
10. ASME - American Society of Mechanical Engineers
11. ASTM - American Society for Testing and Materials
12. AWS - American Welding Society
13. AWWA - American Water Works Association
14. EPA - Environmental Protection Agency
15. FM - Factory Mutual System
16. IMC – International Building Code
17. IPC – International Plumbing Code
18. IRI - Industrial Risk Insurers
19. MSS - Manufacturers Standardization Society
20. NACE – National Association of Corrosion Engineers
21. NEC - National Electric Code
22. NEMA - National Electrical Manufacturers Association
23. NFC - National Fire Code
24. NFPA - National Fire Protection Association
25. NPC - National Plumbing Code
26. NSF – National Sanitation Foundation

27. OSHA - Occupational Safety and Health Standards
28. PDI – Plumbing and Drainage Institute
29. SMACNA - Sheet Metal and Air Conditioning Contractor's National Association
30. UL - Underwriters Laboratories, Inc.
31. State and Local Fire Marshall
32. State and Local Inspection Authorities
33. Owner District's Fire Insurance Agency requirements
34. The Division 01 Sections "Regulatory Requirements" and Reference Standards of the Project Specifications

D. Permits and Inspections
1. Obtain and pay for all permits, bonds, licenses, etc. required by the Local, State or other authority having jurisdiction over the work.
2. Arrange and pay for inspections required by the above when they become due as a part of the work of the Sections affected. Conceal no work until approved by these governing authorities. Present the Owner with properly signed certificates of final inspection before the Owner's acceptance of the Work.
3. Obtain and pay for all meters, gauges, instruments, and devices required by the governing authorities except as otherwise noted as part of the Work of the Sections affected.

1.7 QUALITY ASSURANCE

A. All materials furnished shall be new and shall comply with all applicable standards listed below.

B. All materials or work found to be defective or not in strict conformity with the Contract Documents, or defaced or injured through any cause, shall be rejected and shall be removed by Contractor and satisfactory material and Work substituted without delay.

C. Contractor shall protect his/her Work by keeping all piping, equipment, etc., capped or plugged, drained, or otherwise protected from injury by freezing, water damage, or stoppage from material, concrete, sand, or dirt and shall repair any such injury without additional charge to the User. Injury shall be interpreted to include scratches, discoloring and denting.

D. Contractor will be held responsible for any damage caused by him/her to other Contractors' Work.

E. Submit shop drawings and product data for all equipment as specified or scheduled. Update all drawings to "as-built" status on CD-Rom or flash drive and submit to Architect/Engineer.

1.8 SUBMITTALS

A. Submit under provisions of Division 01 and as specified herein. The most stringent requirements shall apply.

B. General: Within 15 calendar days after date of Contract Agreement, submit to the Engineer a typewritten list of all items of equipment and material proposed for installation on this project. Provide the specification page number, manufacturer's name, model number, size non-standard accessories specified or required, and any other information required to identify each item.
1. Within 30 days after the Contractor has been given notice of approval of manufacturers, submit shop drawings of equipment and material proposed for this installation.

2. If substitutions have been offered in lieu of specified materials and/or equipment they shall be in accordance with AIA Document A201.

C. Shop Drawings: Submit shop drawings for all Work to be done under each of the Mechanical Sections and for all items and assemblies which are to be specifically fabricated for this Contract.

D. The Engineer's review of Manufacturer's Drawings or Schedules shall not relieve the Contractor from responsibility for errors or omissions in Manufacturer's Drawing and deviations from the Contract Drawings or Specifications.

E. Coordination and Fabrication Drawings: Prepare layout drawings of all system assemblies of this Contract including plumbing, heating, sprinkler piping, electrical and technology, mechanical and electrical room layouts with equipment and piping, ductwork installations, and control systems. Include completely dimensioned plans drawn to scale. Show elevations and sections indicating locations of all equipment, piping, ductwork, drains, controls, and other items with reference to columns, walls, slabs, beams, and to components of other systems and work of other trades. Floor plans shall be drawn at not less than 1/4-inch scale with a sign-off block including all disciplines and date. Tracing or reproduction of Construction Documents is not acceptable. Provide a minimum of one reproducible drawing and five prints of each drawing.

F. Electronic files containing AutoCAD Floor Plans or Revit models are available through the Engineer. Cad drawing format shall be AutoCAD 2017 unless requested otherwise. Revit models shall be in the version in which they are created. The Contractor shall complete, sign, and submit a "Model Sharing Agreement" form which is available from the Architect/Engineer by request. Fees may apply for these electronic files.

G. Catalog Cuts: Submit manufacturer's data sheets and pictures of all standard manufactured items proposed for installation in this project. Clearly identify each item proposed, together with all required accessories and fittings, with tag numbers and specification page and line numbers. Include graphs, curves, or charts, as applicable, with the specified operating point clearly marked.

H. Installation and Bolt Setting Diagrams: Submit complete installation instructions and bolt setting information for items of equipment furnished under Division 23 such as pumps, fans, compressors, tanks, filters, pressure vessels, etc.

I. Wiring Diagrams: Provide specific wiring diagrams and instructions for all equipment, controls or devices which are furnished under Division 23 and are to be wired and connected by other trades. The diagrams and instructions shall not be or a general or typical nature but shall be applicable and specific to this Contract.

J. Samples: Where a Contractor proposes a manufacturer, material, or method differing from that specified, the Engineer may require samples illustrative of the manufacturer, material or method. Submit such samples as part of the shop drawing requirements, and shall include samples of insulation, special finishes, etc.

K. Submittals shall be made in accordance with the General Conditions of the Contract and as otherwise required in the Contract Documents. In submitting shop drawings, illustrations, and descriptive material for approval of the Engineer, the Contractor must clearly mark each shop

drawing, catalog cut, pamphlet or specification sheet as follows, for purposes of identification and record:

1. Date: (as submitted)
2. Project Title:
3. Location of Project:
4. Branch of Work: (HVAC, Plumbing, Fire Protection, etc.)
5. Specification Paragraph & Page:
6. Submitted by: (Contractor Name)
7. Contract No.:

1.9 SUBSTITUTIONS

A. Product substitutions shall be in accordance with the General Conditions, Supplemental General Conditions, Division 01 and as specified.

B. The products, equipment, etc. scheduled on the Drawings or specified are the basis of design. Where more than one manufacturer is listed, the Contractor may use any of the acceptable manufacturers as the basis of their bids unless otherwise specified. However, the Contractor assumes all responsibility for changes to the design, installation, etc. as a result of the change, i.e.: power characteristics, physical size, etc.

C. Any request for substitution to other than the specified acceptable manufacturers must be submitted to the Engineer in writing and shall include an adequate description of proposed change, reason(s) for requesting change and cost adjustment information. Substitutions not submitted in this manner will be rejected automatically. Substitution requests will only be considered for the following reasons:
   1. Specified manufacturer(s) is no longer in business.
   2. Specified product(s) cannot be delivered within the required project schedule.
   3. Alternate product(s) is of equal quality, but better value with savings offered to the Owner.

1.10 PROJECT RECORD DOCUMENTS

A. Maintain Project Record Drawings during construction in accordance with General Conditions and as specified.

B. Provide Project Record Drawings at completion of project. Shop drawings are not acceptable as record drawings unless they have been revised to reflect all field changes. Tracing or reproduction of the Contract Documents shall not be acceptable.

C. Show the following information on the Project Record Drawings:
   1. All significant changes in plan, sections, elevations, and details, such as all relocation, or changes in ductwork and piping.
   2. All final locations of controls and final arrangement of electric circuits and any significant changes made in design as a result of change order or job conditions.
   3. Final location and arrangement of all mechanical equipment.

D. Provide AutoCAD Version 2017 or later files, or Revit models on CD-Rom, or flash drive of all Project Record Drawings.

1.11 OPERATING AND MAINTENANCE MANUALS

A. Submittals of operation and maintenance manuals shall be in accordance with General Conditions and as herein specified.

B. Prepare and deliver to the Engineer, 3 complete sets of operating and maintenance manuals for all equipment listed in the Equipment Schedules and when specified by the Section in which the equipment is furnished. Provide all information pertinent to the equipment for preventive maintenance and for replacement of all expendable components. Manuals shall refer only to the actual equipment provided. All reference to alternative equipment shall be deleted. All such literature shall be bound in 3 new standard 3-ring binders and shall be submitted to the Engineer, along with an electronic (PDF) version.

C. Include the items listed below and features as may be recommended by the manufacturers.
1. Catalog information of the unit installed.
2. Capacity and installation details.
3. Wiring diagrams of electrical components.
4. Special valves and control devices.
5. Complete list of parts with reordering numbers.
6. All points requiring lubrication, lubrication frequency and type of lubricant.
7. Operating pressure and temperatures.
8. Design pressures and temperatures.
9. Relief devices and settings.
10. Electrical characteristics of all motors.
11. Operating curves of pumps and fans.
12. Recommended spare parts list.
13. Warranty Information.

D. Prepare operating instructions, complete and explicit, including instructions for start-up, operating, and stopping. Underscore and emphasize critical points of operations and hazardous limit.

E. Items which also must be included are make-up air units, coils, filters, unit heaters, heating and HVAC components, fans, motors, pumps, temperature control systems with a description of the sequence control, vibration isolation, etc.

F. Include flow charts and wiring programs in the manuals indicating valve locations and control devices. Also include parts lists to be used for ordering replacement and repair parts.

G. Arrange information in an orderly manner in accordance with the numbering system used for the project specification. Include a table of contents for each manual.

H. Manual covers shall include the name of the project.

1.12 DELIVERY, STORAGE AND HANDLING

A. Refer to the General Conditions, Standard Specifications and as specified in each individual section.

1.13 WARRANTY

A. Except where otherwise specifically included in individual Sections, all mechanical systems shall be provided with the guarantees as follows.

B. Guarantee all mechanical systems, equipment, materials, and workmanship to be free from defect for a period of 1 year from the date of final acceptance of the Work. Replace or repair in an approved manner any Work which may prove defective or not in compliance with the Contract Documents without additional cost to the Owner and without interference with the Owner's operation. There shall be a mandatory walk thru at 10 months to ensure all equipment/materials are performing as required.

C. Deliver to the Architect/Engineer 3 copies of all manufacturer's or equipment suppliers' warranties as part of the O&M manuals.

D. Make all adjustments required to ensure operation of the various systems in accordance with the intent of the Drawings and Specifications.

E. It is specifically understood that all adjustments to ensure the proper operation of the systems shall cover a period of 12 months following acceptance of the Work, and the Contractors and/or their suppliers shall make all such adjustments required during this period without delay and without additional cost to the Owner.

1.14 TESTING, ADJUSTING AND BALANCING

A. This contractor shall employ services of an independent firm to perform testing, adjusting and balancing.

B. The independent firm will perform services specified in related section.

C. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

D. Test Pressures: Lines shall be tested according to the following schedule:

Line	Test Medium	Minimum Pressure	Minimum Time	Remarks
Heating Water	Water	125 lb.	24 Hours	No Drop
Condensate	Water	125 lb.	24 Hours	No Drop
Chilled Water	Water	125 lb.	24 Hours	No Drop

1.15 OPERATING INSTRUCTIONS TO OWNER

A. Contractor shall furnish Architect/Engineer with a written statement from the Owner certifying acceptance of all the equipment, data and instructions of operation. Architect/Engineer will not approve the request for final payment until this certificate has been submitted.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPLIED BY CONTRACTOR

A. Contractor furnishing an item of equipment is responsible for the proper handling, setting, installation, start-up and initial operation.

B. If Contractor is unfamiliar with the proper start-up and adjustment procedure of any equipment or system furnished by him/her, he/she shall include the services of a qualified representative of

the manufacturer or vendor to provide start-up assistance and for instruction of the Owner's personnel.

C. Contractor shall include all necessary allowances to insure that all equipment and systems furnished will be serviced as required during the guarantee period.

D. When a manufacturer offers an extended warranty at additional cost, such extended warranty shall be included as alternate.

2.2 NOISE AND VIBRATION CONTROL

A. Contractor shall make provisions in the installation of the Work that noises or vibrations will not be transmitted through foundations, floors, walls, columns, ducts and piping, so as to be objectionable in any manner. All equipment provided shall be selected and installed with this in view. If any equipment exceeds reasonable requirements as to quietness of operation and freedom from vibration when operating under continuous maximum demands, it shall be altered or replaced.

B. Furnish and install vibration eliminators and isolation equipment for equipment, motors, and pumps, as indicated on the Drawings, and as specified in related section.

C. The isolation and vibration eliminator manufacturer and Contractor shall be responsible for the selection of the proper units for their loadings, quantities, and each shall guarantee that each and every installation and their application shall have a vibration efficiency of 95% or greater. As a minimum, provide types of vibration eliminators as indicated on the Drawings and specified in related section.

D. Submit shop drawings to the Architect/Engineer for review of all isolation equipment with dimensions and other data as recommended and prepared by the isolation equipment manufacturer.

2.3 GUARDS

A. All belts, pulleys, chains, gears, couplings, projecting set screws, key and other rotating parts shall be fully enclosed and properly guarded.

B. Guards shall be constructed of not less than 1-inch x 1-inch x 1/8-inch structural steel angles and 1/2-inch diamond mesh enclosure or equally suitable enclosure, all of hot-dipped galvanized fabrication.

C. Guards shall be secured to the driven machines or to foundations of floors by heavy galvanized structural angle supports and anchor bolts. Braces or supports secured to motors will not be permitted and braces and/or supports must not "bridge" the sound and vibration isolators.

D. Guards shall be designed with adequate provision for movement of motor required to adjust belt tension. Means shall also be provided to permit lubrication, use of speed counters and other maintenance and testing operation with guard in place.

2.4 MAINTENANCE MATERIALS, SERVICE AND SPARE PARTS

A. This contractor shall be responsible for continued maintenance of all equipment furnished under this contract. This contractor shall, at the time of Owner acceptance, provide the Facilities planning Office with a report detailing the following information:
   1. Dates equipment arrived at the job site.
   2. Installation date.
   3. Dates of maintenance at start-up and at periodic maintenance.
   4. Dates of lubrication changes as applicable and specific name, manufacturer and type of lubrication.

B. Refer to the General Conditions and to the individual Sections for additional requirements.

PART 3 - EXECUTION

3.1 SAFETY PRECAUTIONS DURING INSTALLATION

A. Contractor shall take all measures to ensure safe installation of all Work and to prevent injury to persons or damage to property in compliance with OSHA and all applicable regulations.

B. Contractor shall erect whatever scaffolds, platforms, supports, or other required construction to safely protect his/her own workers and other persons at the site.

C. Such scaffolds, platforms, etc., shall be designed and constructed by Contractor who shall be solely responsible for their adequacy and safety. Engineer, Architect, the Owner, or User is not responsible for ascertaining the adequacy of any temporary structures used or erected by the Contractor.

3.2 INTERRUPTIONS AND TIE-INS

A. Any interruptions and tie-ins to existing systems that are necessary for installation of the new Work shall be performed and completed in coordination with the Owner's representatives. Provide 2 days written notice prior to any tie-in or connection to existing active systems. Any work requiring shut down of systems serving occupied areas shall occur during off hours, unless otherwise scheduled by mutual agreement.

3.3 MODIFICATIONS AND INTERFERENCES

A. Contractor shall carefully check and become familiar with the Architectural, Structural, Electrical and all Mechanical Drawings and Details and make note of all locations where walls, partitions, ceilings, and structural members are called for to be furred or closed-in.

B. Modifications to the arrangement of the piping and ductwork systems may be required to suit structural conditions, or to avoid interference with the Work of other trades. Contractor shall furnish all offsets, additional fittings, etc., as required to meet installation conditions whether detailed on the Drawings or not.

C. Any conflicting information in the Specifications or on the Drawings shall be called to the attention of the Architect/Engineer for clarification before proceeding with fabrication or erection of the parts affected.

3.4 COOPERATION OF CONTRACTORS

A. Each Contractor, in the event of separate contracts in laying out his/her work, shall cooperate with other Contractors on the work so as to avoid any interference with their work. If this is not done, the Architect/Engineer reserves the right to make such changes in the work as are necessary to avoid interferences and such changes will not be considered as cause for additional compensation or extension of time for the Contractor.

3.5 WORK PRIORITY OVER OTHER TRADES

A. Work in cooperation with one another to fit piping and ductwork into structure as job conditions may demand. All final decisions as to right of way and run of pipe, ducts, to be made by the Architect/Engineer. In general, priority is to be arranged as follows:
   1. Recessed lighting fixtures.
   2. Sheet metal ductwork.
   3. Sprinkler heads and sprinkler water lines.
   4. Plumbing waste lines, downspouts and vents.
   5. Refrigeration lines.
   6. Plumbing water lines.
   7. Electrical conduit.

3.6 EQUIPMENT PADS

A. Provide four inch minimum concrete housekeeping pads for all floor mounted equipment.

3.7 ARRANGEMENT AND ALIGNMENT

A. All equipment, ductwork, piping, etc. shall be arranged and aligned in accordance with the Drawings. Elevations, where given, must be held. Floor elevations, where given, are to high points of floor. Dimensions must be held as closely as possible. All dimensions are to be field checked for accuracy before fabrication.

B. Install all equipment, ductwork, piping, etc. straight and direct as possible, generally forming right angles with, or running parallel with, walls or adjacent ductwork, piping, etc. All ductwork, piping, etc. shall be neatly spaced with risers and drops running plumb and true.

C. Run ductwork, piping, etc. in wall chases, shafts, hung ceilings, recesses, etc., where same are provided. Do not run-in floor slab fill unless specifically so noted on Drawings. Ductwork, piping, etc. shall not be covered or closed until testing is completed.

D. Drawings, in general, are made to scale. All dimensions shall be checked in the field by the Contractor before final connections are fabricated.

E. Drawings are, in general, diagrammatic and the exact locations shall be determined by the Contractor from field measurements. The actual arrangement, when erected, shall follow the general locations shown on the Drawings as far as practicable. The installation shall be neat in appearance and convenient to operate.

F. Installations shall be coordinated with other Work to avoid blocking building openings, light fixtures, etc. and shall not interfere with access to valves or equipment. Equipment, ductwork, piping, etc. shall be installed to provide working clearance for operation and maintenance.

3.8 ALIGNMENT OF ROTATING EQUIPMENT

A. All pumps, fans, etc. or similar equipment directly connected to motors by means of flexible couplings must be perfectly aligned after installation by the use of a dial indicator and the Work of alignment must be performed by a craftsman skilled in the Work.

B. Belted equipment shall be aligned so that the grooves of the driver pulley are truly aligned with those of the driven sheave, and the belts must be in the proper tension, free from flutter. In multi-belt drives, all belts must be operated at the same plane. Flutter in any 1 belt will be cause to reject the entire set, as the original installation of belts must be in matched sets.

C. All equipment provided with high-capacity belt drives must be conveniently tagged and so identified for future servicing and replacement of belts.

D. Before any rotating equipment is put in operation for testing purposes, it shall be properly lubricated with lubricants recommended by the manufacturer, and they shall be further lubricated before the equipment is turned over to the Owner.

3.9 CLEARANCES

A. Install ductwork, piping, etc. to provide minimum clearance of at least one (1) inch between extreme projections of piping, flanges, fittings, valves, allowing for insulation, expansion, etc.

3.10 EXPANSION

A. Special attention shall be given to the installation of ductwork, piping, etc. which have an appreciable movement so that they will not hit other ducts, pipes, structural members, etc. under actual operating conditions.

B. Provide flexible connections or expansion compensators where ducts, pipes, etc. cross building expansion joints.

3.11 LOCATION OF VALVES AND PIPING COMPONENTS

A. System components which require observation, operation, or maintenance such as valves, gages, controls, strainers, dirt pockets, cleanouts, unions and flanges, etc., shall be located, whenever possible, so as to be readily accessible. They shall not be concealed in chases or above ceilings without provision for access. Valves which require frequent operation, or which may require emergency operation, and which are 10'-0" from normal working level, should be installed with appropriate provisions such as chain wheels or extension stems.

B. Install all valves with stems in either an upright (preferred) or horizontal position. Control valves shall be installed with top works upward unless specifically shown otherwise.

C. Globe valves should be installed to seat against the direction of flow.

D. Make provisions for draining all low points of all piping systems, whether indicated on the Drawings or not, using a globe or ball valve and iron pipe thread to hose thread adapter with cap. Drains shall not be less than 3/4 inch, subject to sizes indicated on Drawings.

3.12 DRAINAGE AND VENTING

A. Where ducts, pipes, etc. are purposely pitched for drainage or venting, an accurate grade shall be maintained. Lines shall be supported in such a manner as to prevent deflection sufficient to pocket the lines.

3.13 PIPE SIZE DESIGNATIONS

A. All pipe sizes referred to in these Sections should be interpreted as IPS (iron pipe size) unless specifically designated otherwise, such as "O.D." for tubing.

3.14 CUTTING AND PATCHING

A. All cutting, repairing, fitting, and refinishing of in-place construction required for the installation of the Work of a Section, shall be included as part of the Work of that section except as specifically shown on Drawings or hereinafter specified.

B. Work shall be performed by craftsmen skilled in their respective trades.

C. Match existing conditions in color, materials, and texture.

3.15 DUCTWORK PIPE AND EQUIPMENT IDENTIFICATION

A. Piping identification shall be as specified in related section. Equipment identification consistent with the markings on the equipment schedule shall be made following finished painting with paint or stencil letters or numerals as approved by the Architect/Engineer.

3.16 CLEANING - GENERAL AREA

A. Contractor shall assist in maintaining the premises in an orderly fashion at all times, providing continuous clean-up during the construction period. Contractor shall remove all cartons, containers, and crates as soon as the contents have been removed and shall also remove all debris caused by Work as soon as possible. Deposit all discarded materials in a suitable refuse container and prevent these materials from being scattered by the elements. All cartons and debris shall be removed from the premises and site at the sole expense of Contractor.

B. Contractor shall stack all construction materials associated with his/her Work in areas so as to avoid congestion and interference.

C. At the completion of the work, the Contractor shall clean all of his/her work and equipment free from dust and other foreign matter and shall leave the work in good housekeeping condition, in a manner acceptable to the Architect/Engineer.

3.17 WIRING DIAGRAMS

A. Contractors shall provide each piece of electrically connected, controlled, or operated equipment with specific wiring diagrams and instructions. Diagrams and instructions shall not be of a general or typical nature but applicable only to the specific job. The diagrams and instructions used to install the equipment shall be identical to that included in the "Operations and Maintenance Manuals".

3.18 SYSTEM START UP

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify the Architect/Engineer 7 working days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.

D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer. Check ratings of overload relays for each starter.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.

G. When called for in individual Specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.19 DEMONSTRATION AND INSTRUCTIONS

A. Provide the services of a competent supervisor or technician to instruct the Owner's personnel in the operation of each piece of equipment/systems installed as specified in the individual sections. Include not less than the time listed for each of the systems. Where required by the individual section of the specifications, provide the services of factory trained specialists to instruct the Owner's personnel in the operation of the equipment/system so specified.

B. Demonstrate operation and maintenance of products to Owner's personnel, 2 weeks prior to date of completion. Provide an over/outline of the purpose and operation of all equipment installed under this contract.

C. Demonstrate Project equipment and instruct in a classroom environment for up to 10 people, located at the project site and instructed by a qualified manufacturer's representative who is knowledgeable about the Project. Provide documents for all attendees.

D. For equipment or systems requiring seasonal operation, perform demonstration for other season within 6 months.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual in detail with the Owner’s personnel in detail to explain all aspects of operation and maintenance. Training shall include review of temperature control drawings and schematics.

F. Demonstrate start-up, operation, control, adjustment, normal & unoccupied operations, system trouble-shooting, step by step procedure for determining the source of problems on the system level, component trouble-shooting description of diagnostic procedures for determining the source of the problems on the component level, servicing & maintenance instructions of required procedures for weekly, monthly, and annual preventive checks and timely repairs,

sources of spare parts and special tools, and shut-down of each item of equipment at agreed time at designated location.

G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

H. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

I. Training shall include a question-and-answer period.

J. Training shall include special requirements of tenants for equipment’s function.

K. Training shall include any special issues to maintain warranties.

L. Training shall include relevant health and safety issues and concerns, and special safety features.

M. Training shall include Integral Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

N. Training shall include Building Automation Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

O. Training shall include interaction with other systems, and operation during power outage and fire.

P. Training shall include common trouble shooting issues and methods, control system warnings and error messages including using the control system for diagnosis.

Q. Digitally record all instructional sessions and demonstrations. Provide two DVD’s/CD-Rom, labeled with all pertinent information to identify specific equipment or systems, and include in the O & M’s.

3.20 LUBRICATION

A. During the commissioning process and prior to testing, all equipment shall be properly lubricated in accordance with the manufacturer's instructions. One set of tools necessary for lubrication shall be provided by this Contractor.

B. Except for small electrical motors which, under NEMA Standards, are equipped with lifetime lubrication, all bearings on large motors and mechanical equipment shall be equipped with lubrication fittings at all service points, accessibly located. Oil fill and drain line extensions shall be provided where necessary for convenient servicing of equipment.

3.21 TESTING

A. Testing all equipment/systems installed shall be the responsibility of the trade installing the Work under the supervision of an Engineer employed by the Contractor except as specified. The Owner shall employ services of an independent firm to perform testing, adjusting and balancing:

1. The independent firm will perform services specified in related section.
2. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

B. Furnish all gages, instruments, test equipment and personnel required for the tests. Adjust all equipment to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment producing noise that is abnormal, in the opinion of the Architect/Engineer, shall be repaired or removed and replaced with satisfactory equipment at no additional expense.

C. Operate the system and make all adjustments in control and equipment and complete necessary balancing to deliver not less than the air or fluid quantities shown on the Drawings for each equipment item.

3.22 TOOLS

A. On completion of the Work, the Contractor shall furnish and deliver to the Owner any special tools and instrumentation that may be required for the proper servicing or routine testing of any equipment furnished under this Contract.

END OF SECTION 23 0500

SECTION 23 0514

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements; and Division 23 Section “General Mechanical Requirements.”

1.2 DESCRIPTION OF WORK

A. Provide variable frequency drives (VFDs) as specified herein.

B. The VFD shall consist of a pulse-width-modulating (PWM) inverter for positive speed control for standard NEMA design B induction motors used in HVAC applications. The VFDs will be manufactured by Danfoss, Toshiba Inc., Yaskawa, ABB, or Cutler Hammer, and shall be UL-listed.

1.3 SUBMITTALS

A. Shop Drawings: Fabrication drawings indicating materials of construction, unit configurations, dimensions, field connection details, support details and installation details.

B. Product Data
1. All product items specified.
2. Manufacturer’s literature and cut sheets.
3. Wiring diagrams.
4. Weights.
5. Temperature/ambient requirements.
6. Noise and sound data.

C. Samples: Not required for A/E review.

D. Contract Close-Out Information
1. Operating and maintenance data.
2. Training video.
3. Warranties.

1.4 WARRANTY

A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory-certified service technician. Start-up services shall include checking for verification or proper operation and installation for the VFD, its option, its interface wiring to the building automation system, and programming of any critical frequency rejection points.

B. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts and labor.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. VFD systems shall be microprocessor-based and fully transistorized with a conservatively rated 3-phase, full-wave diode bridge input and a PWM sine-coded output waveform. The input diode bridge shall be protected against line noise by a total harmonic distortion below 35% fundamental drive current. This can be accomplished through reduced harmonic technology (RHT) or 5% line reactors. The output transistors must be of the insulated gate bipolar transistor (IGBT) type to facilitate noiseless motor operation. The VFDs shall be tested and rated for a minimum of a 20-year mean time between failure (MTBF). Provide manufacturer's typical test results or calculations with submittal to verify MTBF.

B. To minimize electrical and acoustical noise, and to eliminate low-speed cogging, a minimum switching frequency of 15 khz shall be used. The VFD shall not "cog" at frequencies above 1.5 hz. There shall be no sudden frequency shifts as the output frequency is varied between 1.5 and 60hz.

C. The VFDs input displacement power factor shall be 0.98 or better over the entire operating frequency and load range. Efficiency shall be measured at 96% minimum at rated load. Provide manufacturer's typical test results or calculations with submittal to verify efficiency and power factor.

D. All VFDs shall have, but shall not be limited to, the following protective features:
   1. Solid state output ground fault protection shall be provided.
   2. Adaptive electronics motor overload protection shall be provided which shall protect both the motor and the VFD at all frequencies. Electronic thermal overload circuits which only properly protect the motor at full speed shall not be acceptable. The VFD shall sense the load and speed and shall recalibrate the thermal trip curve to ensure low-speed motor protection. The initial trip point shall be adjustable from at least 40% of the VFD continuous rating to account for motor magnetizing current.
   3. Input surge protection shall be performed by MOVs (metal oxide varistors) in accordance with ANSI Specification C62.41.1 and C62.41.2.

E. Opto-coupled isolated control inputs shall be provided. The motor speed shall be directly proportional, or inversely proportional to 0-10 VDC, 4-20 ma, and variable resistance signals. In addition, the VFD shall have independent settings adjustable on the fly for input reference offset (positive and negative) and gain to facilitate signal setting/matching.

F. VFD operation options shall be programmable, and shall include, at a minimum, the following functions:
   1. User-definable speed upon lost reference signal. Drive to indicate fault upon lost signal.
   2. The standard protocol shall be BACnet. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
   3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable

feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected the ability to change the PID set point. The DDC system shall also be able to monitor if the motor is running in the VFD mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

4. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

G. The VFD shall provide the following operational features:
   1. "Speed search" transfer. The VFD shall have the ability to start from bypass or fault trip into a spinning load from 100% forward to 100% reverse rotation without stopping the motor or creating a fault condition. The VFD shall match the motor's speed and then drive the motor to its proper speed reference.
   2. Programmable current limit.
   3. Programmable, "intelligent" auto-restart function. Intelligent auto-restart precludes any attempt to restart in the event of trips typically indicative of component failure.
   4. Drive must have power loss ride-through capability, for units 5 HP and larger. In the event of a loss of three-phase power lasting 2 seconds or less, the VFD must have the ability to regain operation without nuisance trips.
   5. Critical Frequency Rejection Points: Drives shall be capable of programming up to 3 frequency rejection points to protect the driven equipment from continuous operation at harmful resonance frequencies.
   6. The following fault conditions shall cause the VFD to shut down without damage and shall be annunciated via alpha-numeric fault diagnostic (remote annunciation shall be available with a form 'c' fault contact):
      a. Overload (blow fuse any or all legs/loss of phase)
      b. Instantaneous over current trip (short circuit)
      c. DC bus overvoltage
      d. DC bus under voltage, phase loss protection
      e. Excessive ambient, VFD heat sink over temperature
      f. Ground fault input
      g. Internally diagnosed, control failure
      h. Motor thermal overload
      i. VFD thermal overload
      j. Programmable "shear pin" current trip

2.2 PROGRAMMING/OPERATOR STATION

A. Include alpha-numeric display of frequency reference, output frequency, output current (accurate +/-3%, regardless of output frequency), output voltage, DC bus voltage, output power (kW), input terminal status, output thermal status, LED lamp check, and EEPROM number.

B. Alpha-numeric display of faults. Up to 4 sequential faults shall be retained in non-volatile memory (maintained even after removal of input power). All system information (voltage levels, current levels, etc.) shall be stored for the previous 3 seconds before the last fault in 160 nsec intervals to aid in diagnostics.

C. VFD systems located outdoors shall be mounted in a NEMA 3R stainless steel enclosure. VFD systems located in indoor wet/damp rooms or indoor rooms with water systems such as chiller or boiler rooms shall be mounted in a NEMA 12 enclosure. VFD systems mounted in indoor dry rooms without water systems shall be mounted in a NEMA 1 enclosure. All enclosures shall be provided with the following additional equipment requirements:
   1. Door-mounted digital operator control station.
   2. Door-interlocked input circuit breaker with flange-mounted pad-lockable operating handle.
   3. Three (3) contactor bypass to fully isolate the VFD. The VFD must be able to be run for testing purposes while the motor is operating in the bypass mode.
   4. Output 3-phase current sensing overload relay to provide motor protection in either the VFD or bypass mode.

D. VFD systems shall be full load tested prior to shipment.

E. DV/DT – All VFDs operating multiple motors are required to have a DV/DT filter. All VFDs operating a single motor with a wire distance of more than 100 feet are also required to have a DV/DT filter. The DV/DT filter will limit the rated voltage rise over time to prevent the breakdown of motor winding insulation and reduce the motor operating temperature. The DV/DT filter can be mounted internally to the VFD enclosure or supplied externally in close proximity to the VFD. If supplied externally, the DV/DT filter shall be mounted in a NEMA enclosure matching the VFD NEMA enclosure type. The DV/DT filter shall be UL listed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed per manufacturer’s recommendations.

B. Label all control components to match the control and wiring diagrams.

C. All motors controlled with VFDs shall be provided with a shaft grounding system to electrically insulate bearings to prevent damage due to stay shaft currents.

END OF SECTION 23 0514

SECTION 23 0519

METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section the includes the following types of meters and gauges:
   1. Temperature gauges and fittings.
   2. Pressure gauges and fittings.

B. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 21, 22 and 23 sections.

1.3 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment and material item specified.

B. Product Data: Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

C. Samples: Not required for review.

D. Contract Close-Out Information
   1. Maintenance data for each type of meter and gauge in each building for inclusion in Operating and Maintenance Manuals specified in Division 01, and Division 23 Section "Common Work Results for HVAC".
   2. Portable test plug test kit and portable meter receipts as described in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Mercury-In-Glass Thermometers
   a. Marshalltown Instruments, Inc.
   b. Trerice (H.O.) Co.
   c. Weiss Instruments, Inc.
2. Thermometer Wells: Same as thermometers.
   a. Insertion Dial Thermometers.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Trerice (H.O.) Co.
   d. Weiss Instruments, Inc.
3. Pressure Gauges
   a. Ametek, U.S. Gauge Div.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Marsh Instrument Co., Unit of General Signal.
   d. Marshalltown Instruments, Inc.
   e. Trerice (H.O.) Co.
   f. Weiss Instruments, Inc.
4. Pressure Gauge Accessories: Same as for pressure gauges.
   a. Water Orifice-Type Measurement System.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett, ITT, Fluid Handling Div.
5. Test Plugs
   a. MG Piping Products Co.
   b. Peterson Equipment Co., Inc.
   c. Sisco, A Spedco, Inc. Co.
   d. Trerice (H.O.) Co.
   e. Watts Regulator Co.
   f. Flow Design, Inc.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.
   1. Scale Range: Temperature ranges for services listed as follows:
   2. Domestic Hot Water: 30 deg to 240 deg with 2 deg scale divisions (0 deg to 115deg C with 1 deg scale divisions).
   3. Domestic Cold Water: 0 deg to 100 deg F with 2 deg scale divisions (minus 18 deg to 38 deg C with 1 deg scale divisions).
   4. Heating Hot Water: 30 deg to 300 deg F with 2 deg scale divisions (0 deg to 150 deg C with 1deg scale divisions).
   5. Chilled Water: 0 deg to 100 deg F with 2 deg scale divisions (minus 18 deg to 38 deg C with 1 deg scale divisions).

2.3 MERCURY-IN-GLASS THERMOMETERS

A. Case: Die-cast, aluminum finished in baked epoxy enamel, glass front, spring-secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, mercury-filled magnifying lens.

D. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum, or brass, for separable socket, length to suit installation.

2.4 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal stainless steel case and stem, 1-inch diameter dial, dust and leakproof, 1/8-inch diameter tapered-end stem with nominal length of 5 inches.

2.5 THERMOMETER WELLS

A. Brass or stainless steel, pressure-rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.6 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube-type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inch diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1% of range span.

F. Range: Conform to the following:
1. Vacuum: 30 inch Hg to 15 psi
2. All fluids: 2 times operating pressure

2.7 PRESSURE GAUGE ACCESSORIES

A. Siphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.8 FLOW METERS, GENERAL

A. Flow rate of elements and meters shall be same as connected equipment or system.

2.9 WAFER ORIFICE-TYPE FLOW ELEMENTS

A. Type: Differential-pressure wafer-type orifice insert flow elements designed for installation between pipe flanges.

B. Construction: Cast iron body, brass valves with integral check valves and caps, and calibrated nameplates. Elements shall be pressure-rated for 300 psig and 25 deg F (120 deg C).

2.10 METERS

A. Portable Meters: Differential-pressure gauge and two 12-foot hoses in carrying case with handle.

B. Scale: 0-100 ft. of water unless otherwise indicated.

C. Accuracy: Plus or minus 0.5% of full scale.

D. Each meter shall be furnished complete with operating instructions.

2.11 TEST PLUGS

A. Test plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and two self-sealing valve-type core inserts suitable for inserting a 1/8 inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:
1. Air, Water, Oil, and Gas, 20 deg to 200 deg F (minus 7 deg to 93 deg C): Neoprene
2. Air and Water, minus 30 deg to 275 deg F (minus 35 deg to 136 deg C): EPDM

C. Ranges of pressure gauge and thermometers shall be approximately two times systems operating conditions.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install in the following locations and elsewhere as indicated:
1. At inlet and outlet of each hydronic boiler and chiller
2. At inlet and outlet of each AHUs heating hot water and/or chilled water coil

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most legible position.

B. Install in the following locations, and elsewhere as indicated:
1. At suction and discharge of each pump.
2. At discharge of each pressure-reducing valve.
3. At building water service entrance.

C. Pressure Gauge Needle Valves: Install in piping tee with snubber. Install siphon in lieu of snubber for steam pressure gauges.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most legible position. Secure cap.
   1. Install test plugs adjacent to each piping point where a temperature sensing device is required by control specifications.

B. Test Kit: Provide test kit consisting of one pressure gauge, gauge adapter with probe, two bimetal dial thermometers, and carrying case. Turn over to Owner at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.4 INSTALLATION OF FLOW-MEASURING ELEMENTS AND METERS

A. General: Install flow meters for piping systems located in accessible locations at most legible position.

B. Locations: Install flow measuring elements in the following locations and elsewhere as indicated:
   1. At discharge of each inline pump.

C. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.

D. Install wafer orifice-type element between two Class 125 pipe flanges, ANSI B16.1 (cast iron) or ANSI B16.24 (bronze).
   1. Install connections for attachment to portable flow meters in a readily accessible location.

E. Meters for Use with Flow Elements: Install meters on wall or bracket in accessible location.
   1. Install connections, tubing, and accessories between flow elements and meters as prescribed by the manufacturer's installation instructions.

F. Window Flow Meters: Install in vertical upward position with impact tube mounted in bushing centered on pipe with 10 pipe diameters upstream and 5 pipe diameters downstream of straight unrestricted piping for 1-1/4 inch and smaller, 20 pipe diameters upstream and 10 pipe diameters downstream for 1-1/2 inch AND LARGER. Calibrate meter after installation in accordance with manufacturer's installation instructions.

3.5 PORTABLE METERS

A. Provide one portable meter as described in Part 2 of this Section. Turn over to Owner at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.7 CONNECTIONS

A. Piping installation requirements are specified in other sections of ***Division 21, 22 and 23***. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gauges piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION 23 0519

SECTION 23 0523

VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section includes valves for the following systems:
   1. Heating Water.
   2. Chilled Water.
   3. Makeup Water
   4. Cooling Coil Condensate Drain Water.

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data
   1. Manufacturer's cut sheets and/or literature.
   2. Performance Data

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
   2. Operating and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.
   4. ASME Boiler Code Specifications for Boiler Room Valves.

C. ASTM Compliance
   1. ASTM B62 for 125 psi and 150 psi saturated steam rated valve pressure containing parts.
   2. ASTM B61 for 200 psi and 300 psi valves with metallic seats.

D. Factory test all Valve Bodies, Shells and Seats per MSS requirements as a minimum.

E. Iron Body Valves
1. Pressure-Containing Parts: ASTM A126, Grade B.
2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71, 85.

F. Butterfly Valves
1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

G. Valve Stems: ATM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

H. Valve-End Connections
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B 16.18.
3. Threaded: With threads according to ASME B1.20.1.
4. Grooved: With grooves according to Victaulic published dimensions.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Pressure Casting shall be free of impregnating materials, no welding of iron allowed.

K. Manufacturer’s name or trademark and working pressure stamped or cast into body.

L. Valves shall be rated at least 20% over the maximum system working pressure and not less than required for system temperatures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Sizes shall be the same as upstream piping unless otherwise indicated.

B. Valve Bypass and Drain Connections: MSS SP-45.

C. Combination Balancing and Shutoff Valves.
1. Install where shown on Drawings. Valves shall be designed and used only for balancing.
2. Provide a means for connecting to a portable differential pressure meter for readout. A portable pressure gauge, hoses and flow curves shall be provided in a portable test kit.
3. On sizes 2-1/2 inches and larger, valve size, capacity and operating pressure must comply with ASME boiler and pressure vessel code: section IV.
4. Refer to manufacturer’s recommendations for upstream and downstream straight piping lengths.

D. Coil Piping Packages/Coil Hook Ups
1. Contractor has the option to use factory assembled valve packages in lieu of individual valves and ports as shown on the drawings at any terminal unit connections.
2. Shall only be provided on pipes 2 inches and smaller.
3. All components shall be rated for 125 psig working pressure and shall be full-port (full-bore) design.

4. The order and arrangement of components shall be consistent with the Drawings.
5. Each individual component shall meet the specification requirements for components of a field-assembled system.
6. Acceptable manufacturers: Victaulic/Tour Andersson, ITT Bell & Gossett, Flow Design and Griswold.

E. Multi-Purpose (Three-Function Valve)
1. Can be used in lieu of Combination Balancing/Shutoff Valve and Check Valve at Pump Discharge.
2. Triple Duty Valve manufacturer must be the same as pump manufacturer.
3. Horizontal or vertical installation is acceptable; valve may be field convertible for straight or angled position.
4. Valve shall be a ductile iron body, bronze seat disc, with a 302 stainless steel spring.
5. Valve stem shall be made of bronze or 416 stainless steel with seal packing replaceable under pressure.
6. Bronze fitted construction.
7. Valve shall have a memory indicator, pointer and scale.
8. Schrader valve or P/T port metering connections.
9. O-ring sealed valve body shall be EPDM.
10. Replaceable 'soft seat' shall be EPDM.
11. The valve, in the full-open position shall have no more than a 1 psi pressure drop across the valve.
12. Valve shall be constructed with a minimum of 125# working pressure (maximum 250#).
13. Valve shall be available in threaded for 2" and smaller and flanged or grooved end connections in sizes 2-1/2 inches and larger.

2.2 HVAC SYSTEMS (heating water, chilled water, condenser water, make-up water and cooling coil condensate drain) WITH OPERATING TEMPERATURES UP TO 200 DEG F.

A. Start/Stop Flow; 2 Inches and Smaller
1. Type: 2-piece full port ball.
2. Minimum ANSI Class: 150 SWP (600 WOG).
3. Body Material: Cast bronze (ASTM B 584).
4. Seal Material: Reinforced PTFE.
5. Ends: Threaded or soldered for copper piping.
6. Ball Material: 316 stainless steel.
7. Stem Material: 316 stainless steel.
8. Operator: Hand lever.

B. Start/Stop Flow; 2-1/2 Inches and Larger
1. Type: Butterfly.
2. Minimum ANSI Class: 150 WOG.
3. Body Material: Cast iron.
4. Seat Material: EPDM.
5. Ends: Full lug flange.
6. Disc Material: Aluminum bronze.
7. Stem Material: 416 stainless steel.
8. Operator: 10-position hand lever for less than 6 inches, gear actuator for 6 inches and larger.

9. Other: Valves and Seats shall be rated for 150 psi shutoff during dead-end service, without downstream piping or flange.
10. Option for grooved piping systems: 300 psi CWP suitable for bi-directional and dead-end service at full rated pressure. Body shall be grooved end ductile iron conforming to ASTM A536. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat.
    a. 2-1/2" through 12": Victaulic Style 300 MasterSeal™.
    b. 14" through 24": Victaulic AGS Style W761 300 MasterSeal™.

C. Prevent Back Flow; 2 Inches and Smaller
1. Type: Check – Horizontal swing or vertical lift.
2. Minimum ANSI Class: 125 SWP (200 WOG).
3. Body Material: Bronze (ASTM B 62).
4. Disc Material: Reinforced PTFE.
5. Ends: Threaded or Soldered for copper piping.
6. Cap: Threaded.

D. Prevent Back Flow; 2-1/2 Inches and Larger
1. Type: Swing check.
2. Minimum ANSI Class: 125 SWP (200 WOG).
3. Body Material: Cast iron (ASTM A 126).
4. Disc Material: Cast iron (ASTM A 126).
5. Seat Ring Material: Bronze (ASTM B 62).
6. Ends: Flanged.
7. Cap: Bolted.
8. Option for grooved piping systems: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi.
    a. 2-1/2" through 12": Victaulic Series 716 (Or Series 779 with Venturi taps).
    b. 14" through 24": Victaulic AGS Style W715.

E. Prevent Back Flow; 2-1/2 Inches and Larger
1. Type: Globe body silent check valve.
2. Minimum ANSI Class: 125 SWP.
3. Body Material: Cast iron (ASTM A 48, Class 35).
4. Disc Material: Cast iron with bronze face rings.
5. Ends: Flanged or wafer.
6. Seat Material: Bronze (ASTM B584).
7. Plug Material: Bronze (ASTM B584).
8. Spring Material: Stainless steel T304 (ASTM A 276).

F. Acceptable Manufacturers: Milwaukee, Hammond, Crane, NIBCO, DeZurik, Watts, Tyco, Victaulic or Mueller.

G. Regulate/Balance Flow; 2 Inches and Smaller
1. Type: Combination balancing and shutoff valve (calibrated Y-Pattern globe).
2. Minimum Pressure: 300 psi.
3. Body Material: Non-Ferrous (DZR) Brass alloy.

a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.

4. Ends: Flanged, threaded or soldered for copper piping.
5. Seat Seal Material: EPDM.
6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: 4-Turn hand wheel with hidden memory stop.
8. NOTE: Ball type valves not acceptable as balancing device.

H. Regulate/Balance Flow; 2-1/2 Inches and Larger
1. Type: Combination balancing and shutoff valve (venturi globe type).
2. Minimum Pressure: 300 psi.
3. Body Material: Ductile iron.
4. Ends: Flanged, grooved or threaded.
5. Seat Seal Material: EPDM.
6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: Multi-turn handwheel with hidden memory stop.
8. NOTE: Butterfly type valves not acceptable as balancing device.

I. Acceptable Combination Balancing and Shutoff Valves are: Victaulic/Tour Andersson, Armstrong, ITT Bell & Gossett, Griswold, Taco or Flow Design.

PART 3 - EXECUTION

3.1 STORAGE, HANDLING, AND EXAMINATION

A. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

B. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

C. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

D. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

E. Examine threads on valve and mating pipe for form and cleanliness.

F. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

G. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves at locations shown on the Drawings, per the Specifications and in accordance with manufacturer's written instructions.

B. Locate valves for easy access and provide separate support where necessary.

C. Service/isolation valve shall be provided at every piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown and minimal disruption to the piping service.

D. Install Combination Balancing and Shutoff Valves at each branch connection to return main.

E. Install Start/Stop flow valve for isolation at each branch connection to supply main.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. All check valves should be installed in a location that has smooth and laminar flow conditions.

H. For swing type check valves, locate valve a minimum of 10 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 5 pipe diameters downstream of valve.

I. For silent type check valves, locate valve a minimum of 4 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 3 pipe diameters downstream of valve.

J. Install valves in horizontal piping with the hand wheel and stem at or above center of pipe.

K. Install valves in position to allow full stem movement.

L. Valves installed in copper lines shall be provided with screwed or flanged adapters with a union installed downstream and within 12 inches of the valve.

M. Install chainwheels on operators for all valves located with the lowest portion of its handwheel or lever at 10 feet or more above finished floor. Extend chains to 5 feet above finished floor.

N. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

O. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 23 0523

SECTION 23 0529

HANGERS, SLEEVES, AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes but is not limited to: Pipe hanger and supports, Pipe and equipment anchors and Pipe sleeves.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.4 SUBMITTALS

A. Shop Drawings: Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members, Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Operating and maintenance data, Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers: Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Concrete Anchors: Phillips, Hilti, and Powers.

C. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

D. Pipe and Equipment Anchors: Shop-fabricated, Field-fabricated.

E. Sleeves: Shamrock Industries, "Crete-sleeve" plastic hole forms, Proset Systems Inc., "Proset" fire-safe pipe penetrations, Shop for field fabricated.

F. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc.

2.2 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Cadmium plated carbon steel, adjustable swivel split ring. Use PVC coated or copper plated for copper piping.

B. Hangers for Pipe Sizes 2 to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Carbon steel, adjustable, clevis type. Use copper plated for copper piping.

C. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.

D. Hangers for piping that gets insulated shall be sized to allow insulation to be continuous through hangers.

E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for hot pipe sizes 6 inches and over.

F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

G. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 6 inches and over.

H. Vertical Support: Steel riser clamp.

I. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

J. Shield for Insulation Piping 16 gage galvanized steel shield over minimum 12 inches long at pipe support. 360-degree insulated saddle system consisting of a factory assembled 2.5 PCF density 25/50 Flame/Smoke rated phenolic foam pipe insulation with .02 perm rated vapor retender film with self-sealing lap. Buckaroos model 255OFS or equal.

2.3 HANGER RODS AND ATTACHMENTS

A. Steel Hanger Rods: Threaded both ends, threaded one end, and continuous threaded. Use cadmium plated rods where unconcealed or exposed to the elements.

B. Minimum pipe hanger rod sizes are as follows:

Pipe Size	Rod Diameter
Up to 2 Inches	3/8 Inch
2-1/2 Inches & 3 Inches	1/2 Inch
4 Inches	5/8 Inch
6 Inches	3/4 Inch
8 Inches to 12 Inches	7/8 Inch
14 Inches to 18 Inches	1 Inch
20 Inches to 30 Inches	1-1/4 Inch

C. Beam Clamps (up to 8-inch diameter pipe): Top beam clamp, steel jaw, hook rod with nut and spring washer steel eye-bolt. C-clamps by themselves are expressly prohibited unless otherwise approved by Structural Engineer

2.4 INSERTS

A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 PIPE SLEEVES AND SEALANTS

A. Sleeves – General: Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:
1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping
1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.
4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
   a. Insulated chilled water and DX lines: Type CS-CW.
   b. Other insulated pipes: Type CS.
3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes
1. Length: Ends flush with finished surfaces.
2. Diameter
   a. Minimum 3 inch.
   b. Minimum 1 inch larger than pipe and pipe insulation.
   c. In concrete, 1-1/2 inch larger than pipe.
   d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.
1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity. Provide proper material for each typical application as described by manufacturer.
2. Acceptable Manufacturers: Dow Corning "Fire Stop", Nelson "Flameseal", 3M "Fire Barrier", Pipe Shields Inc., Model WFB, DFB, or QDFB Series, Proset Systems.
3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations
1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E. Permission from A/E will only be provided when required due to construction schedule timing issues. If permission from A/E is provided, Powers BANG-IT concrete insert or approved equal shall be used.
5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction. At first elbow of equipment run out piping risers and horizontal piping within 10 feet of all circulating base mounted pumps having 4-inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Steel Liquid	Steel Vapor	Copper Liquid	Copper Vapor
1/2 - 1 inch	7 ft.	8 ft.	5 ft.	6 ft.
1-1/4 - 2 inch	7 ft.	9 ft.	7 ft.	9 ft.
2-1/2 - 3 inch	11 ft.	12 ft.	9 ft.	12 ft.
3-1/2 - 4 inch	12 ft.	12 ft.	11 ft.	12 ft.
5 - 6 inch	12 ft.	12 ft.	12 ft.	12 ft.
8 - 30 inch	12 ft.	12 ft.	12 ft.	12 ft.

B. For Schedule 40 or Schedule 80 PVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

Schedule 40 or 80 PVC		
Pipe Diameter	Liquid	Vapor
1/2 - 1 inch	3 Ft.	3 Ft.
1-1/4 - 2 inch	3 Ft.	3 Ft.
2-1/2 - 3 inch	6 Ft.	6 Ft.
3-1/2 - 4 inch	7 Ft.	7 Ft.
5 - 6 inch	8 Ft.	8 Ft.
8 - 14 inch	12 Ft.	12 Ft.

C. Provide a hanger within 1 foot or less of each horizontal elbow and valves that are above 3 inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than 6 feet, provide only 1 hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For piping of other materials, space hangers according to manufacturer's recommendations.

E. Pipe Hanger Loading
1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

F. Trapeze Hangers: Suspend trapeze hangers from concrete inserts of approved structural clips. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

G. Vertical Pipe Supports: Support all vertical pipe runs in pipe chases at base of riser. Support pipes for lateral movement with clamps or brackets.

H. Concrete Inserts: Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required. Provide concrete inserts in time for installation in concrete.

3.3 DUCT HANGERS

A. Install necessary hanger rods and angle iron support brackets to properly support, ductwork, insulation, reinforcing, and external loads. Fiction clamps are excluded as upper attachment devices.

B. Max spacing of supports to be as follows:

Rectangular Duct		
1/2 x Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)

Rectangular Duct		
1/2 x Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Less than 72	3/8	10
72 to 120	3/8	8
120-192	1/2	5

Round Ducts		
Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Through 24	1/4	12
25 through 36	3/8	12
37 through 50	1/2	12

1. Use a pair of rods, 1 on each side of ductwork. Rods to be uncoated, hot-rolled steel.
2. OPTION: 1 inch wide sheet metal straps may be used on sizes up to 22 inches wide (or 22 inches in diameter), 1 sheet metal gauge (minimum) thicker than ductwork being supported.

3.4 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors: Provide as indicated and required to permit complete installation of system. Do not anchor piping to plaster or gypsum wallboard partition walls. Provide anchoring devices at locations indicated. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.5 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.6 MISCELLANEOUS STEEL

A. Piping Contractor (or Heating Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel. Repair galvanized steel at field cuts and connections.

END OF SECTION 23 0529

SECTION 23 0548

VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 23 Section “Hangars, Sleeves, and Supports” for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems
1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

1.4 SUBMITTALS

A. Shop Drawings
1. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
2. Special details necessary to convey complete understanding of the work to be performed.

B. Product Data
1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
   a. The equipment identification mark.
   b. The isolator type.
   c. The actual load.
   d. The static deflection expected under the actual load.
   e. Specified minimum static deflection.

f. The additional deflection to solid under actual load.
g. The ratio of spring height under actual load to spring diameter.

3. Spring Isolators
   a. Spring diameter.
   b. Deflection.
   c. Compressed spring height.
   d. Solid spring height.
   e. Point location of each isolator.
   f. Load at each point.
   g. Field static deflection.
   h. Horizontal loading and bolt requirements.
   i. Indicate all bases and rail clearances.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Operating and maintenance data.
   2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Fans and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	**Vibration Displacement (MILS Peak-to-Peak)**
Under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
Over 2000 rpm	1

C. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices
   1. Mason Industries, Inc.

2. Amber/Booth Co.
3. Kinetics Noise Control.
4. The VMC Group.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.
1. Acoustical sealant D.A.P.
2. BR-96 Pecora.
3. Acoustical sealant Tremco.
4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.
1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, and welded concrete pouring forms from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:
1. All steel parts to be hot-dip galvanized.
2. All bolts to be cadmium-plated.
3. All springs to be cadmium-plated and neoprene-coated.

D. Coordinate the requirements of this Section with those of Division 23 Section “Seismic Restraint”.

E. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

F. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

G. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

H. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators
1. Type 1 Isolators: Double-deflection neoprene mountings.
a. Minimum static deflection: 0.35 inch.
b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
c. Friction pads both top and bottom to eliminate the need for bolting.
d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.

e. Mason Industries, Type ND; or Vibration Mountings & Controls, Type RD.

2. Type 2 Isolators: Spring-type.
   a. Free-standing and laterally stable, without any housings, snubbers, or guides.
   b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.
   c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
   d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
   e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
   f. Mason Industries, Type SLF.
3. Type 3 Isolators: Spring-type with vertical limit stop.
   a. Equal to Type 2 isolator, except that mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.
   b. Installed and operating heights to be the same.
   c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.
   d. Limit stops to be out of contact during normal operations.
   e. Mason Industries, Type SLR.
4. Type 4 Isolators: Neoprene wafer pads.
   a. Durometer or hardness to suit application.
   b. Square waffle pattern on 1/2-inch centers.
   c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
   d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
   e. Provide type "W" adhesive, both sides, for all non-bolted applications.
   f. Mason Industries, Type "W", "WMW", "WML", or "WM".

B. Vibration Hangers
1. Type 5 Isolators: Steel spring-type hanger.
   a. Steel spring and 0.3 inch deflection neoprene element in series.
   b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
   c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
   d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
   e. Mason Industries, Type 30N.
2. Type 6 Isolators: Precompressed steel spring-type hanger.
   a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.
   b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
   c. Mason Industries, Type PC30N.
3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.
   a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
   b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.

c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.
d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.
f. Mason Industries, Type W30.

4. Type 8 Isolators: Double-deflection neoprene-type hanger.
   a. Minimum static deflection: 0.40 inch
   b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
   c. Provide hanger for direct attachment to flat iron duct straps.
   d. Mason Industries, Type WHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.
1. Rectangular, except for equipment which may require "T" or "L"-shaped.
2. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.
3. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.
4. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.
5. Mason Industries, Type WF.

B. Type B: Steel rail.
1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
2. Members must be sufficiently rigid to prevent strains in the equipment.
3. Mason Industries, Type ICS.

C. Type C: Structural steel and concrete base.
1. Rectangular structural beam or channel concrete forms for floating foundations.
2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.
5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2 inch above bottom, or additional steel as is required by structural conditions.
6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.
8. Mason Industries, Type K (Type BMK).

D. Type D: Curb-mounted base.

1. Factory-assembled isolation base that fits over roof curb and under the isolated equipment.
2. Provide extruded aluminum top member to overlap bottom member to provide water run-off independent of the seal.
3. Provide cadmium-plated springs with a 1-inch minimum deflection with 50% additional travel to solid.
4. Spring Diameter: Not less than 0.8 of spring height at rated load.
5. Provide resilient snubbers in corners with minimum clearance of 1/4-inch for wind resistance.
6. Provide a weather seal of continuous closed-cell sponge material both above and below base and a waterproof flexible ductlike EPDM connection.
7. Foam or other contact seals are not acceptable at spring cavity closure.
8. Mason Industries, Type CMAB.

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.
   1. Construction: 4 inch thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
   2. Glass Fiber Pads
      a. Inorganic inert material with loading capacity up to 500 psig.
      b. Covered with an elastomeric coating to increase vibration dampening and to protect media.
   3. Concrete Caps
      a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.
      b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12 inch o.c. each way.
   4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.
   1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.
   2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.
   3. Make isolation bases 1 foot larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.
   4. Make isolation bases minimum 1’-2” thick with top of pad 4 inches above finished floor slab.
   5. Reinforce isolation bases as indicated in specifications and drawings.
   6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4-inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:
1. Mason Industries, Type ADA.
2. Peabody Noise Control, Type RGN.
3. Vibration Mounting & Controls, Type MDPA.
4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector
1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.
5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
7. If control rods are used, they must have 1/2-inch-thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joins shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.
   1. Stainless steel braid and carbon steel fittings.
   2. Sizes 3-Inch and Larger: Flanged.
   3. Sizes 2-1/2-Inch and Less: Male nipples.
   4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

2.9 FLEXIBLE DUCT CONNECTIONS

A. Flexible duct connections shall be UL/FM-approved, fabricated from coated fabric (or loaded vinyl as called for on the drawings). The clear space between connected parts shall be a minimum of 3 inch and the connection shall have 1.5 inch minimum of slack material. Connections shall be suitable for not less than 10 inch w.c. operating static pressure.

PART 3 - EXECUTION

3.1 APPLICATION

A. General
   1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
   2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.
      a. Minimum static deflections may be revised subject to prior approval.
      b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.
         1) Provide revised vibration control equipment to match revised or substituted equipment.
   3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
      a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.
      b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
      c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
      d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
      e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
      f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.

g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.
h. No pipes or equipment are to be supported from other pipes or equipment.
i. Resiliently isolated pipes are not to contact the building construction or other equipment.
j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

B. Major Equipment
1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.
2. Flexible duct connections are to be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the Drawing.
3. Flexible pipe connections, are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Resilient Pipe Hangers and Supports
1. Isolation hangers shall be used for all piping in equipment rooms and up to 50 feet from vibrating equipment. To avoid reducing the effectiveness of equipment isolators, at least the first three hangers from the equipment shall provide the same deflection as the equipment isolators, with a maximum limitation of 2-inch deflection; the remaining hangers shall be spring or combination spring and rubber with 0.75-inch deflection. The first two hangers adjacent to the equipment shall be the precompressed type, to prevent load transfer to the equipment flanges when the piping system is filled.
2. Floor-supported piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators. The first two adjacent floor supports shall be the restrained spring type, with a blocking feature that prevents load transfer to equipment flanges as the piping is filled or drained. Where pipe is subjected to large thermal movement, a slide plate (PTFE, graphite, or steel) shall be installed on top of the isolator, and a thermal barrier shall be used when rubber producers are installed directly beneath steam or hot water lines.
3. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral guides.
4. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
5. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently isolated.

3.2 VIBRATION ISOLATORS

A. Type 1 – Not used.

B. Type 2 – Not used.

C. Use Type 3 isolators for:
1. All boilers.
2. All chillers.

3. All air handling units.
4. Minimum static deflections, 1.5 inch.

D. Type 4 – Not used.

E. Use Type 5 vibration hangers for:
1. Individual runs of piping, 3-inch and smaller.
2. All in-line fans.
3. All suspended in-line pumps, 2hp and smaller.
4. Minimum static deflections, 0.3 inch.

F. Use Type 6 vibration hangers for:
1. Trapeze-type pipe hangers.
2. Individual runs of piping, 4 inch through 6 inch.
3. Minimum static deflection, 1.5 inch.

G. Type 7 – Not used.

H. Type 8 – Not used.

3.3 BASES AND RAILS

A. Use Type A, B, C, and D – Not used.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on:
1. All base-mounted pumps.

B. Type IP2 – Not used.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.
1. Pump Suction and Discharge
   a. Exception: When three or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.
2. Chiller Inlet and Outlet
   a. Exception: When three or more mechanical grooved pipe (Victaulic type) couplings are used at each chiller evaporator and condenser outlet and inlet.
3. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.
1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.

1. Indicate specific applications on shop drawings.

3.6 FLEXIBLE DUCT CONNECTIONS

A. Sheet metal ducts or plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. The fan unit or adjacent duct section shall be able to move 1 inch in any direction without causing metal-to-metal contact or stretching taut the flexible connection.

3.7 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be vibration isolation hanger.

B. First three floor-mounted pipe supports shall rest on Type 3 isolators.

C. If piping is connected to equipment located in basements and hangs from structure under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and including 3 inch; 1.5 inch deflection for pipe sizes up to and including 6 inch; and 2.5 inch deflection thereafter.

D. Locate hanger as close to overhead supports as is practical.

END OF SECTION 23 0548

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Piping identification.
   2. Valve identification.
   3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1-2015, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

F. The naming/numbering/tagging convention used must be a coordinated effort between the Mechanical Contractor, Controls Contractor, Owner, and A/E and must be approved by all parties prior to implementation. The naming/numbering/tagging convention must be consistent and reflected through the building automation control system, charts, diagrams, tagging and O&M manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers
   1. Craftmark Identification Systems.
   2. W. H. Brady Co.
   3. EMED Company, Inc.
   4. Kolbi Industries, Inc.

5. 3M Co.
6. Seton Name Plate Corp.

2.2 PIPE MARKERS

A. Conform to ANSI A13.1-2015.
1. Pressure-sensitive vinyl (self-sticking) material.
2. Mechanically Fastened Type: Snap-on or strap-on.
a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
3. Provide with direction of flow arrows.
4. Size of Letters Legend

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

2.3 VALVE TAGS

A. Brass or Anodized Aluminum Type
1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:
a. Service: 1/4-inch stamped black filled letters.
b. Valve numbers: 1/2-inch stamped black filled letters.
2. Aluminum: 2-inch diameter, 0.032-inch thick, with following lettering:
a. Service: 1/4-inch engraved letters.
b. Valve numbers: 1/2-inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.4 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.
1. Two 3/8-inch mounting holes.
2. Lettering size: Minimum 1/2 inch high.
3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.5 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. The naming/numbering/tagging convention used must be a coordinated effort between the Mechanical Contractor, Controls Contractor, Owner, and A/E and must be approved by all parties prior to implementation. The naming/numbering/tagging convention must be consistent and reflected through the building automation control system, charts, diagrams, tagging and O&M manuals.

B. Designate all equipment, valves, and dampers by distinguishing numbers and letters on charts and/or diagrams.
   1. Tag and locate following equipment items:
      a. Valves.
      b. Dampers.
      c. Air Handling unit.
      d. Pumps.
      e. Fans.
      f. Fan Coil units.
      g. Chillers.
      h. Boilers.
      i. Terminal Boxes.

C. Install tags on all devices with numbers and letters corresponding to charts.

D. Fasten tags securely to devices with tag fasteners in manner for easy reading.

E. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, fans, HVAC units and control panels.
   1. Secure nameplates with self-tapping screws, or nuts and bolts.

F. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

G. Furnish 4 charts including device number, location (room number, department) and purpose.
   1. Mount 1 chart in frame and secure on wall in location directed by Owner.
   2. Include remaining 3 sets in "Operation and Maintenance Manuals."

H. Provide all devices located above ceilings with additional identification.
   1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
   2. Coordinate with the Owner on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Locate pipe markers as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take-off.
   3. At each passage through walls, floors, and ceilings.
   4. At each pipe passage to underground.
   5. On all horizontal pipe runs every 20 feet, at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.

B. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 SERVICE ABBREVIATIONS

A. General

1.	CHS	Chilled Water Supply
2.	CHR	Chilled Water Return
3.	CWS	Condenser Water Supply
4.	CWR	Condenser Water Return
5.	D	Drain
6.	PC	Pumped Condensate
7.	HWS	Heating Hot Water Supply
8.	HWR	Heating Hot Water Return
9.	HPS(#PSI)	High-Pressure Steam
10.	MPS(#PSI)	Medium-Pressure Steam
11.	LPS(#PSI)	Low-Pressure Steam
12.	HPC	High-Pressure Steam Condensate
13.	MPC	Medium-Pressure Steam Condensate
14.	LPC	Low-Pressure Steam Condensate
15.	PSC	Pumped Steam Condensate
16.	RS	Refrigerant Suction
17.	RL	Refrigerant Liquid
18.	GS	Geothermal Supply
19.	GR	Geothermal Return
20.	HS	Heat Pump Supply
21.	HR	Heat Pump Return

3.4 CONTROL SEQUENCE OF OPERATION AND DIAGRAMS

A. Provide HVAC control and systems sequence of operations and diagrams in wall mounted frames.
   1. Mount framed diagrams in conspicuous, easily accessible places in equipment rooms housing appropriate HVAC system.

B. Diagrams and instructions may be reduced in size, provided they are easily readable.

END OF SECTION 23 0553

SECTION 23 0593

MECHANICAL SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
   1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
   2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
   1. Air distribution systems.
   2. Air moving equipment.
   3. Circulating water systems, Heating and Chilled Water.
   4. Instrumentation and control system.
   5. Direct Expansion (D/X) Refrigeration system
   6. Heating systems
   7. Cooling Systems

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF HEATING CONTRACTOR’S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

C. Maintain accessibility to test locations and devices requiring adjustment.

D. Add dampers required for correct air balance as recommended by the Air Balance Agency.

E. Provide additional sets of pulleys and belts as recommended by the Air Balance Agency.

F. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Mechanical Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Construction Manager (CM)/ Owner
   1. If balancing is not preformed during peak cooling season, demonstrate satisfactory balancing during next peak cooling season.
   2. If balancing is not preformed during peak heating season, demonstrate satisfactory balancing during next peak heating season.

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the CM/Owner may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data.
         2) All equipment nameplate information.
         3) All traverse readings.
         4) Line sketch/diagram indicating location of traverses.
         5) Static pressure profiles.
         6) AABC equipment data sheets.
         7) Fan and pump curves.
         8) Temperature readings (all air and water streams)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.
   1. If requested, conduct tests of instruments in presence of CM/Owner.

B. If requested, conduct balancing tests in presence of CM/Owner.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 AIR BALANCING METHODS

A. Balance each air system that is serviced by air filters, using artificial static loading of system, to demonstrate, test and obtain system design pressure drop data.
   1. Provide dirty filter pressure drop conditions on system.
   2. Do not use high efficiency filters (75% and above) in testing and balancing.
   3. Static pressure losses may be simulated by using wood or sheet steel blanking plates in high efficiency filter racks and housings.
   4. Do not install blanking plates within 2 feet of any low efficiency filter unit or rack.

3.3 AIR BALANCE TESTING PROCEDURE

A. Perform tests and balance system in accord with the following.

B. Test and adjust equipment capacity to design requirements and record RPM.

C. Test motor load amperes and fan rotations.

D. Make pitot tube traverse of main supply ducts and obtain design CFM at fans. Provide fan curves and plots.

E. Test system static pressure, suction and discharge.

F. Test and adjust system for design CFM outside and return air:
   1. Maximum outside air setting.
   2. Minimum outside air setting.

G. Test and adjust system for design CFM outside air.

H. Test coil entering air temperatures:
   1. Dry bulb deg F heating and cooling.
   2. Wet bulb deg F cooling.

I. Test Leaving Air Temperatures
   1. Dry bulb deg F heating and cooling.
   2. Wet bulb deg F cooling.

J. Adjust all main supply and return air ducts to proper design CFM.

K. Adjust all zones to proper design CFM, supply and return.

L. Test and adjust each diffuser, grille, and register to within 10% of design requirements.
   1. Identify location and area of each grille, diffuser, and register.
   2. Identify and list size, type and manufacturer of diffusers, grilles, and registers.
   3. Use manufacturer's ratings on all equipment to make required calculations.
   4. Readings and tests of diffusers, grilles, and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.
   5. Adjust all diffusers, grilles, and registers to minimize drafts.

M. In cooperation with control manufacturer's representative, set automatically operated dampers to operate as indicated.
   1. Check all controls for proper calibration and list all controls requiring adjustment by control installers.

N. Balance supply, return, and exhaust air to provide the designed pressure relationships to adjacent areas.

O. Make any changes in pulleys, belts, and dampers, to achieve capacity.

P. Check fire dampers and smoke dampers for correct operation and damper position.

Q. Adjust special equipment fans to CFM requirements as indicated.

R. List all mechanical nameplate and specifications of fans.

3.4 WATER BALANCE PROCEDURE - PHASE ONE

A. Complete air balancing before commencing water balancing.

B. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.

C. Check operation of all relief valves.

D. Examine water in system and determine if water has been treated and cleaned.

E. Checks pump rotation.

F. Check expansion tanks to determine they are not air-bound.

G. Check for installation and proper operation of air valves.

H. Set temperature controls for all coils at maximum cooling. Check for full closure of all automatic bypass valves at coil and chiller. Use similar procedure for checking bypass valves on hot water coils at maximum heat setting.

I. Check operation of automatic bypass valves.

3.5 WATER BALANCE PROCEDURE - PHASE TWO

A. Ensure start-up strainers have been removed.

B. Set pumps to specified gallons per minute delivery.

C. Adjust water flow of chilled water to supply main.

D. Adjust water flow of hot water to supply main.

E. Check chilled water entering temperatures and return water temperatures at mains. Reset to correct design temperatures.

F. Check water temperatures at inlet side of cooling and heating coils. Record temperature difference from source.

G. Balance each chilled water and hot water coil.

3.6 WATER BALANCE PROCEDURES - PHASE THREE

A. After completing coil balancing, test hot and chilled water pressures and flows at the pumps and re-adjust if required.

B. Adjust Coil Bypass Valves: Install pressure gages on coil, read pressure drop through coil at flow rate for maximum cooling, and again for maximum heating.
   1. Set pressure drop across bypass valve to match coil maximum flow pressure drop.
   2. Adjust flow rate through each coil in coil banks.

C. Check following at each cooling and heating unit.
   1. Inlet water temperatures.
   2. Leaving water temperatures.
   3. Pressure drop of each coil.
   4. Pressure drop across bypass valve.
   5. Pump operating suction and discharge pressures and final total dynamic head.
   6. Water metering device readings.

D. List all mechanical specifications of pumps.

E. Record nameplate and actual operating amperages of pump motor.

3.7 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours' duration each for heating and cooling systems to demonstrate to satisfaction of the CM/Owner that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 23 0593

SECTION 23 0700

HVAC INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. Section Includes
   1. Duct Insulation.
   2. Pipe Insulation.
   3. Equipment Insulation.
   4. Insulation Adhesive.
   5. Insulation Sealant.
   6. Insulation Mastic.
   7. Insulation Jacketing.

1.3 QUALITY ASSURANCE

A. All testing and ratings shall meet the standards set in ASTM E-84, NFPA 255, and UL 723.

B. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50. Outdoor insulation shall have a flame-spread rating not exceeding 75 and a smoke developed rating not exceeding 150.

C. Insulation accessories shall have the same or better ratings as the insulation product they serve.

D. Insulation values shall be in accordance with the State Energy Codes.

E. Maximum insulation temperature limits must exceed maximum fluid working temperatures.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with flame and smoke ratings, and maximum use temperature.

B. Protection: Leave insulation boxed and stored until time for use. Elevate and cover material to avoid moisture, dust, and physical abuse.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields with ductwork and piping installer.

B. Coordinate clearance requirements with piping installer for piping insulation application and ductwork installer for duct insulation application, and equipment installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fiberglass Insulation: Owens-Corning, Knauf, CertainTeed, Johns Manville, and Manson.

B. Closed-cell Insulation: Aeroflex, Armacell, and K-flex.

C. Calcium Silicate Insulation: Owens-Corning, Johns Manville, or Industrial Insulation Group (IIG).

D. Adhesive: Foster, Johns Manville, and 3M.

E. Sealant: Foster, Boss Products, and Dow Chemical.

F. Mastic: Foster.

G. Aluminum Jacketing: Ideal Products, Pabco, and RPR Inc.

H. PVC Jacketing: Proto, and Johns Manville.

2.2 GENERAL

A. Products shall not contain asbestos, lead, mercury, or mercury compounds and be HCFC free.

B. Use of water-soluble treatments is prohibited.

2.3 TYPES OF INSULATION

A. Type 1: Fiberglass heavy-density insulation with all service jacket and pressure sealing lap adhesive on longitudinal and butt strips. Jacket vapor membrane shall have an installed vapor permeance of not more than 0.09 perms. Staple and seal with pressure-sealing lap adhesive on longitudinal and butt strips. Thermal conductivity (k-value) not greater than 0.23 at mean temperature of 75 deg F.

B. Type 2: Flexible closed cell elastomeric thermal pipe insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

C. Type 3: Flexible fiberglass duct wrap laminated to foil-reinforced kraft vapor membrane facing with 2 inch stapling flange. 1.0 pcf density with thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

D. Type 4: Semirigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 3.0 pcf density with thermal conductivity (k-value) not greater than 0.23 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

E. Type 5: Rigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 6.0 pcf density with thermal conductivity (k-value) not greater than 0.22 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

F. Type 6: Flexible closed cell elastomeric thermal sheet insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

G. Type 7: Rigid hydrous calcium silicate insulation ASTM C533, C795 Type 1. Thermal conductivity (k-value) not greater than 0.42 at 200 deg F. Mitered or scored to fit designed circumference. Rated for 1200 deg F. Install in staggered joint position over high-rib metal lath. Field-applied 0.016-inch-thick aluminum jacketing secured with sheet metal screws over wire or stainless steel banding.

H. TYPES OF JACKETING

I. Type 1: PVC jacket. 0.030-inch-thick ultraviolet-resistant PVC jacket. Jacket is to be self-extinguishing and have zero fuel contribution.

J. Type 2: Aluminum jacket. 0.016-inch-thick aluminum jacket with “Pittsburgh Seam.” Seal between metal jacket and sleeve.

K. Type 3: Rubberized bitumen membrane. 0.060 inch thick. Designed with a cross laminated high strength polyethylene laminated to raw aluminum. This film is then laminated to rubberized bitumen compound with a release liner. Self-healing if punctured, UV stable, and will expand and contract with the mechanical system. “Alumaguard” / “Alumaguard Lite” as manufactured by Polyguard. Install a layer of “Alumaguard” on the top & sides of duct and “Alumaguard Lite” on the bottom. For cold weather installations the “Alumaguard LT” as manufactured by Polyguard, can be used. Install per manufacturer’s instructions.

2.4 FITTINGS AND VALVES

A. Premolded PVC covers over molded insulation. Insulation same thickness as on adjoining pipe. Insulation shall have a flame-spread rating not exceeding 25 and a smoke-developed rating not exceeding 50.

2.5 SCHEDULE OF INSULATION

System Type	Fluid Temperature Range (F)	Insulation Type	Insulation Thickness					
			1" and smaller	1" to 1-1/4"	1-1/2" to 3"	4" to 6"	8" and larger	Duct or Equip.
Hydronic Piping								
Heating Water	100 – 200	1	1.5	1.5	2.0	2.0	2.0	N/A
Condenser Water (*A)	60 – 100	1	0.5	0.5	1.0	1.0	1.0	N/A
Chilled Water	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Cooling Coil Condensate	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Make-up Water	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Refrigerant	Below 40	1 or 2	0.5	1.0	1.0	1.5	1.5	N/A
Duct								
Supply	45 – 120	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.5
(*A) Return	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
Outside Air	-20 – 120	3 (*C)	N/A	N/A	N/A	N/A	N/A	2.0
(*B) Relief Air	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
(*B) Exhaust	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
Equipment								
Heating Water Tanks	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Heating Water Heat Exchangers	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Heating Water Air Separators	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Chilled Water Pumps	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Chilled Water Tanks	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Chilled Water Heat Exchangers	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Chilled Water Air Separators	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Note: For piping and ductwork exposed to outdoor temperatures, increase thickness by 0.5 inches.								
*A: Only ductwork/Piping in non-air-conditioned areas (Including: Shafts, Ceiling space with roof above, and Attics) or ductwork/Piping exposed to outdoor temperatures.								
*B: Only ductwork/Piping exposed to outdoor temperatures or ductwork from plenum at louver (or other outside opening) back to motorized or backdraft damper.								
*C: For visible rectangular ductwork (non-mechanical rooms) or ductwork installed outside use Type 4 or Type 5 insulation. For mechanical rooms use Type 4 or Type 5 insulation for rectangular ductwork with bottom of duct elevation below 10 feet A.F.F.								

2.6 EXPOSED INDOOR PIPING LESS THAN 10 FEET ABOVE NEAREST WALKING SURFACE

A. Cover piping insulation with Type 1 or Type 2 Jacketing.

2.7 OUTDOOR PIPING

A. Cover piping insulation with Type 2 Jacketing.

2.8 OUTDOOR DUCTWORK

A. Cover ductwork insulation with Type 3 Jacketing. For the top of rectangular ductwork, under the jacketing provide tapered insulation centered on the duct to slope to the sides for drainage. Tapered insulation shall run the entire length of duct.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Verify that systems and equipment to be insulated have been tested and are free of defects.

C. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in schedule of insulation.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Apply insulation with duct and pipe surfaces at room temperature.

M. Make insulation continuous except through fire-rated walls/floors. Do not leave gaps in insulation at sleeves, hangers, anchors, supports, etc.

N. Insulate all fittings, valve bodies, flanges, and other pipe accessories.

O. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 3 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

S. For insulation at hangers and bracing, see Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”

3.4 EQUIPMENT INSULATION INSTALLATION

A. Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
      d. Do not overcompress insulation during installation.
      e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      f. Impale insulation over anchor pins and attach speed washers.
      g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
   7. Stagger joints between insulation layers at least 3 inches.
   8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
   9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
   10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 DUCT INSULATION INSTALLATION

A. Flexible fiberglass duct wrap installations: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
      c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
   4. Impale insulation over anchors and attach speed washers.
   5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
   7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
   8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
   10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Semi-rigid and rigid fiberglass board installations: Secure board insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Space anchor pins as follows:
   a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
   c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.6 PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 PIPING CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 PIPING FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 PIPING CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes
   1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
   2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
   3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
   4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
   3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties
   1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   2. Install insulation to flanges as specified for flange insulation application.

3. Finish valve and specialty insulation same as pipe insulation.

END OF SECTION 23 0700

SECTION 23 2113

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, and joining methods, for the following systems:
   1. Heating Water piping.
   2. Chilled Water piping.
   3. Condenser Water piping.
   4. Makeup Water piping.
   5. Cooling Coil Condensate Drain piping.

1.2 SUBMITTALS

A. Provide coordination drawings per Division 23 Section “General Mechanical Requirements”.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

D. Grooved mechanical piping systems shall be installed according to grooved manufacturer’s installation instructions. All grooved piping products shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as grooved components.

PART 2 - PRODUCTS

2.1 PIPING

A. For piping 4 inches and smaller: Schedule 40 black steel pipe, furnace-butt welded, continuous welded (ASTM A53, Type F) or Drawn-Temper Copper Tubing (ASTM B 88, Type L).

B. For piping 5 inches and larger: Schedule 40 black steel pipe, electric-resistance welded (ASTM A53, Type E, Grade B).

2.2 PIPE FITTINGS

A. For Piping 2 Inches and Smaller
   1. Steel Pipe:
      a. Welded Wrought-Steel Fittings (ASTM A234).
      b. Cast-Iron Threaded Fittings, Class 125 (ASME B16.4).
      c. Malleable-Iron Threaded Fittings, Class 150 (ASME B16.3).
   2. Copper: Welded or Soldered Wrought-Copper (ASME B16.22)

B. For Piping Larger Than 2 Inches
   1. Steel Pipe:
   2. Welded Wrought-Steel Fittings (ASTM A234)
   3. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings, minimum Class 150 rating (ASME B16.5)
   4. Copper: Soldered Wrought-Copper (ASME B16.22)
   5. Elbows shall be long radius.

C. Grooved Mechanical-Joint Fittings and Couplings
   1. Contractors with minimum of 5 installed grooved mechanical-joint systems may use grooved mechanical joint fittings and couplings on roll grooved standard weight Schedule 40 piping 2 inches to 60 inches.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic grooved mechanical-joint fittings and couplings. If another manufacturer is used with a manufacturer's torque requirement, the contractor shall create a log of the measured torque at every mechanical joint.
   3. Grooved End Fittings: Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall, or fabricated from Std Wt Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633. (Fittings 14" and larger shall be supplied with Victaulic factory AGS grooved ends).
   4. Couplings 2" through 12": Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000.
      a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9 and NFPA 13.
         1) Victaulic Style 107N QuickVic®. Installation ready rigid coupling for direct stab installation, without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.
      b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
         1) Victaulic Style 177 QuickVic®. Installation ready flexible coupling for direct stab installation, without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.
   5. Couplings 14" through 60": Couplings shall consist of two ASTM A-536 ductile iron housing segments with wedge shaped AGS key profile and lead in chamfer.

a. Rigid Type: Victaulic Style AGS W07. Coupling key designed to fill wedge shaped AGS groove. Gasket shall be Grade “E” EPDM with green color code designed for operating temperatures from -30 Deg F to +230 Deg F.
b. Flexible Type: Victaulic Style AGS W77. Coupling key designed to fill wedge shaped AGS groove and allow for linear and angular movement, vibration attenuation, and stress relief. Gasket shall be Grade “E” EPDM with green color code designed for operating temperatures from -30 Deg F to +230 Deg F.

6. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness.
7. Victaulic prefabricated pump drop assemblies, which include check valves, butterfly valves, strainers, suction diffusers, flexible couplings (style 177 or W77), and grooved pipe, may be used in lieu of individual components. Victaulic Series 380, 381, 382.
8. Vic-Headers: Victaulic prefabricated factory-fabricated grooved end header [manifold] all-in-one assembly for fluid distribution. Header shall consist of an ASTM A53, Grade B, standard weight pipe spool with required outlet connections. Grooved ends roll grooved to Victaulic AGS dimensions, with enamel coating or galvanized to project requirements.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals (Pipes 2 inches and less): ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals (Pipes greater than 2 inches): AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated without major deviations. Major deviations shall be approved by the A/E on Coordination Drawings prior to installation.

B. Coordinate the exact location of this work, with the work of other trades prior to fabrication or installation and verify all dimensions and elevations. Provide additional offsets and sections of piping as may be required to meet the applicable job conditions. Coordinate with and review all related drawings of all trades prior to start of work.

C. Main piping shall be run horizontal with no slope. Branch piping shall pitch down back to main piping, uniformly a minimum of one inch in 60 feet.

D. Provide trapped cooling coil condensation piping from outlets of drain pans of all cooling coils. Pitch all cooling coil condensation piping down a minimum of 1 inch in 30 feet in the direction of flow. Install insect screen at outdoor terminations.

E. Minimum pipe size shall be 3/4 inch unless noted otherwise.

F. Provide eccentric fittings and/or eccentric reducing couplings in all cases where air or water pockets would otherwise occur in the main due to reduction in pipe size. Eccentric fittings shall keep the pipes flush on top for water piping and flush on the bottom for condensate or drain piping.

G. Do not run piping over or within 3 feet of electrical switchgear, panels, or similar equipment.

H. No piping shall pass through walls at an angle of other than 90 degrees.

I. No pipe, piping fittings, or coverings shall in any way extend partly into any plastered wall or ceiling.

J. Install piping concealed in walls, ceilings, webs of columns, or furring where possible, unless otherwise approved by the A/E and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

M. No piping shall be installed in a manner that will interfere with doorways, door and window operation, ventilation equipment, ductwork, lighting and outlets or other equipment, nor prevent proper vibration isolation or service of equipment or components.

N. Install all piping in locations and elevations such that coils, tubes, and filters can be removed and replaced without major piping removal.

O. Install piping to permit valve servicing.

P. Install piping to allow application of insulation.

Q. Install groups of pipes parallel to each other (where applicable).

R. If a hole is required after the structure is cast, its location and size shall be approved by the A/E and structural engineer. Core-drill the hole. Maintain the fire integrity of the structure.

S. All fittings shall be far enough away from plastered surfaces to allow space for installation of escutcheons. Escutcheons must not extend over any irregular parts of the walls, with all voids between piping materials and construction being properly filled in an approved manner. Provide nickel-plated steel escutcheons on all exposed pipes passing through walls, ceiling, floors, and partitions.

T. Provide unions or flanges of suitable temperature and pressure rating between all dissimilar metals including where copper tubing or components are connected to steel or cast iron piping or components. Unions on copper tubing shall be solder-type, copper-to-copper, up to and including 2-inch pipe size, and flanged 150-pound brass companion flanges for 2-1/2-inch pipe size and above.

U. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

V. Install flange or grooved coupling in piping, 2-1/2 inch and larger, at final connections to valves, apparatus, and equipment and elsewhere as indicated.

W. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration producing equipment.

X. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. The use of nipples welded directly into piping for branch take-offs will not be permitted.

Y. Install expansion loops, expansion joints, anchors, and pipe alignment guides as indicated on drawings.

Z. Install drains, consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

AA. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

3.2 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook".

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Align threads at point of assembly.
   2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   3. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
   4. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Align flanges surfaces parallel with gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

I. Grooved Joints: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Install piping in accordance with latest installation instructions. Verify gasket is suitable for intended service. Factory trained representative (direct employee of grooved manufacturer) shall provide on-site training for contractor’s field personnel.

3.3 SLEEVES

A. Provide sleeves wherever pipes pass through building construction. Anchor all sleeves to building construction. Size sleeves to permit passage of insulation where insulation is required. Maintain the fire integrity of walls, floors, ceilings, and partitions.

B. Where pipes pass through foundation walls or footings, provide cast iron sleeve and caulk the space between sleeve and pipe with lead wool, watertight.

C. Install sleeves in floors perfectly plumb and sleeves in walls level. Center the pipe in the sleeve. Pack sleeves with fire rated materials, per shop drawings, approved submittals, and caulk in tight.

D. Set sleeves in walls, floor, and foundations during the construction.

E. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings and floors, maintain the fire-rated integrity.

3.4 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 125 psi for a length of 6 hours. No pressure drop shall occur over this duration. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the hydronic system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.5 CLEANING

A. At completion of project, thoroughly flush each of the various HVAC hydronic circulating systems with a cleaning solution as recommended by the chemical supplier so as to remove any oil, rust, dirt, scale, or grease that may be present.

B. Utilize water treatment provider’s instructions to clean system. Drain and rinse systems completely with clean water, and clean all screens and strainers.

C. After cleaning is complete, drain system and rinse with fresh water. The chemical supplier shall test and check drain water for pH level and condition.

D. Submit report to the Engineer on condition and finalized method of chemical treatment recommended by the chemical supplier and utilized for this project.

E. If drain water indicates an acid level, neutralize the system with an alkaline-type material as recommended by the chemical supplier and reflush entire system.

END OF SECTION 23 2113

SECTION 23 2116

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
1. Air separators.
2. Expansion tanks.
3. Safety relief valves.
4. Chemical feeders.
5. Thermometer wells and test gage connections.
6. Thermometers and pressure gages.
7. Combination pressure and temperature test stations.
8. Flexible Connectors
9. Air vents.
10. Strainers.
11. Unions.
12. Drains.

1.3 QUALITY ASSURANCE

A. All specialties to be ASME-labeled for ratings specified

B. Coils to bear ARI certification label

C. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

D. Grooved end specialties shall be of the same manufacturer as the adjoining couplings.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data
1. Manufacturer's cut sheets and/or literature.
2. Performance data.

C. Grooved joint specialties shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Close-Out Information
   1. Operating and maintenance data.
   2. Warranty.

1.5 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position specialties for equipment clearance and accessibility and operational conditions.

B. Specialty manufacturer shall verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data shall take precedence over indicated figure or model number.

PART 2 - PRODUCTS

2.1 HYDRONIC AIR SEPARATORS

A. Hydronic air separators, unless otherwise noted on the Drawings, shall have flanged connections, shall be of the model size to accommodate the maximum system flow rate, and shall include a stainless steel system strainer. Provide manual globe-type air vent valve at high point and hose-end globe drain valve with chain, cap at low point of separator assembly, and piping increasers and reducers as required by inlet and outlet sizes. Separators shall be as made by Bell and Gossett, Armstrong, Wood, Taco, or approved equal.

2.2 BLADDER TYPE EXPANSION TANKS

A. Expansion tanks shall have a bladder that is suitable for the temperatures and type of solution served.

B. Initial and final air side charge shall be provided by the Contractor as directed by the Engineer.

C. Tanks shall be ASME stamped and rated for 125 psig system working pressure.

D. Tanks shall be as made by American Tube and Controls Company, Bell and Gossett, Taco, Wood, Armstrong, or approved equal, of the minimum size and capacity as noted or scheduled upon the Drawings.

2.3 SAFETY RELIEF VALVES, WATER

A. 2-1/2-Inch and Smaller: Farris, screwed, 10% over pressure.

B. 3-Inch and Larger: Farris, flanged, 10% over pressure.

C. Provide test levers.

D. Same capacity as system served.

E. Safety relief valve discharge piping shall spill over floor drains.

2.4 CHEMICAL FEEDERS

A. Provide type of treatment and chemical dosages in accordance with water analysis as recommended by the manufacturer of the treatment chemicals.

B. Chemical Feeders: Pot-type feeders constructed for operating pressure of 150 psi.
1. Capacity of Feeders: 3-gallon minimum.
2. Dome bottom bypass feeder, Model DB-5HD as manufactured by J.L. Wingert Co.

C. Water Treatment System Piping: Same type as system piping served.

2.5 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Temperature Sensing Walls
1. Brass or stainless steel.
2. Provide extension necks for insulated piping.
3. Provide test thermometer well adjacent to each point where a temperature-sensing device is required by control specifications and where piping schematics indicate thermometers.

2.6 THERMOMETERS

A. Weiss Model DVU35 digital self-powered, glass passivated thermistor, internal potentiometer with 6-inch stem. Thermometer wells to be brass or stainless steel, 2-inch extension in insulated piping. Provided threaded cap nut and cap. Or approved equal by Ashcroft or Trerice.

B. Thermometers Range Schedule

	Range (deg F)
Heating Hot Water	50 – 250
Chilled Water	0-100

2.7 PRESSURE GAGES

A. General
1. 4-1/2-inch dial, surface or flush-type, white face, black numerals, black pointers, bronze bourbon tubes and shatterproof glass.
2. Pressure Gage Range Schedule

	Range PSIG	Fig Interval PSIG	Inter Gradations PSIG
Chilled And Heating Hot Water	0 - 100	5	1

3. Waterlines: Ashcroft 1010 with 1092 gage cock and 1106 pulsation dampeners.

B. Pump Suction and Discharge Gages: Liquid filled, indicating range 0-100 psig.
1. Provide pressure snubbers for all pump and chiller pressure gauges.

2.8 COMBINATION PRESSURE AND TEMPERATURE TEST STATIONS

A. Pressure/Temperature Test Station, Combination
   1. "Pete's Plug," to receive either a temperature or pressure probe 1/8-inch o.d.
   2. Fitting: Solid brass, 1/4-inch MPT, with two valve cores of neoprene (maximum 200 deg F at 500 psi) or Nordel (maximum 275 deg F at 500 psi).
   3. Provide long length (XL) at all locations with pipe insulation.
   4. Provide with color-coded and marked cap with gasket, rated at 1000 psi at 140 deg F.
   5. Provide at locations shown on equipment and piping schematic drawings.

B. Pressure Gage Adapter
   1. 1/8-inch o.d. probe and 5-inch stem pocket testing thermometers each.
   2. Provide two 25-125 deg F for chilled water.
   3. Provide two 0-220 deg F for hot water.

C. Pressure and Temperature Test Kit
   1. 0-100 psi, 0-230 ft. w.g. gage with a No. 500 gage adapter thermometer.
   2. 0-200 deg F pocket testing thermometer.
   3. No. 500 gage adapter.
   4. Protective carrying case.

2.9 FLEXIBLE CONNECTORS

A. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

B. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

C. Option: Flexible couplings may be used in lieu of flex connectors. Three couplings for each connector shall be place in close proximity to the source of vibration. Victaulic S/177 flexible couplings. See Section 23 21 13.

2.10 AIR VENTS

A. Air Vents - Manual
   1. Vent Valves: 1/4-inch 125 psi globe angle valve with XH nipple connecting to pipe.

B. Air Vents - Automatic
   1. 150 psi rated, minimum.
   2. Maximum working Pressure: 100 psig
   3. Maximum Temperature: 220 deg F
   4. Cast iron body with renewable valve and seat.
   5. Synthetic rubber disc.
   6. Armstrong AAE-750.

2.11 STRAINERS

A. General: Provide full line size strainers ahead of all water control valves, pressure regulating valves, suction side of pumps, and as indicated.

B. Hydronic Strainers
1. Y, T or basket-type, screwed, grooved or flanged.
2. 2 inches and smaller, brass body, screwed ends.
3. 2-1/2 inches and larger:
   a. Cast iron body, flanged ends.
   b. Ductile iron body, grooved ends.
4. Work Pressure, Non-Shock: 300 psig cwp.
5. Screens: Bronze, monel or stainless steel.
6. 2 inches and less: 3/64-inch perforations.
7. 2-1/2 inches and 3 inches: 1/16-inch perforations.
8. 4 inches and larger: 8-inch perforations.

2.12 UNIONS

A. Unions: Of same type, pressure rating and material as piping.

B. Flanges: Raised face type of same type, pressure rating and material as piping.

C. Unions in Copper Pipe
1. 2 Inches and Smaller: Use wrought copper solder joint copper to copper unions.
2. 2-1/2 Inches and Larger: Use brass flange unions.

D. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

E. Dielectric Unions or Waterway Fittings: Standard products for prevention of galvanic corrosion.

2.13 DRAINS

A. Drains: 3/4-inch ball valve or as indicated on the Drawings.

B. Drains from Safety Valve
1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap except where valve drains are required.

D. Drains Pipe to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

2.14 ACCEPTABLE MANUFACTURERS

A. Thermometers
1. Marsh Instrument Co.

2. Ashcroft.
3. Dwyer.
4. Marshalltown Instrument Inc.
5. Palmer Instruments.
6. Taylor Scientific Instruments.
7. Miljoco.
8. Weiss Instruments.
9. Weksler Instruments Corp.
10. Weston and Ernst.
11. Trerice.

B. Pressure Gages
1. Ashcroft.
2. Dwyer.
3. Marsh Instrument Co.
4. Miljoco.
5. US Gauge/Ametek.
6. Weiss Instruments.
7. Weksler Instruments Corp.
8. Weston and Ernst.
9. Trerice.

C. Pressure/Temperature Test Station (Pete's Plug)
1. Peterson Equipment Company, Inc.
2. Flow Design.
3. Sisco.

D. Flexible Connectors
1. Minnesota Flexible Corp.
2. Mason Industries.
3. Twin City Hose.
4. Pipe Solutions LTD.
5. Metraflex.
6. Flexicraft Industries.
7. Southeastern Hose Co.
8. Victaulic

E. Manual Air Vents
1. Crane.
2. Jenkins.
3. Johnston Corp.
4. OIC.
5. Powell.
6. Stockham.
7. Walworth.

F. Automatic Air Vents
1. Armstrong.
2. Spirax Sarco Inc.
3. Hoffman.

4. Bell & Gossett.
5. Thrush.
6. Taco.
7. Fisher.
8. Johnston Corp.

G. Hydronic Water Strainers
1. O.C. Keckley Co.
2. Armstrong.
3. Mueller Steam Specialty.
4. Tate Temco, Inc.
5. Victaulic.

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties according to manufacturer's instructions and as specified.

3.2 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Provide test thermometer well adjacent to each point where a temperature sensing device is required by control specifications and where piping schematics indicate thermometers.

3.3 THERMOMETERS

A. Where temperature control requires a temperature transmitter, a thermometer will not be required in same location unless specifically required in equipment specifications.

B. Where two or more pumps are headered, provide one thermometer in suction header and one in discharge header.

3.4 PRESSURE GAGES

A. Install filter-type pressure snubbers at pumps and chillers.

B. Install brass tee-handle cock and 1/4-inch hard tempered tubing from gage to pipe connection.

C. Install additional brass tee-handle cock at gage for panel mounted gage.

D. Calibrate and zero all gages at job site.

3.5 AIR VENTS

A. Air Vents - Manual
1. Vents shall prevent any part of system from being air-bound.
2. Pipe discharge of vent to a location where air and water may be collected in a bucket.
3. Provide at all trapped high points of cooling and heating piping systems, whether or not indicated.

B. Air Vents - Automatic

1. Provide shut-off valve ahead of vent.
2. Provide copper relief line from valve to drain or drip pan.
3. Provide at each high point in closed water systems and coil headers in air handling units.

3.6 STRAINERS

A. Y-Type Strainers: Same size as piping served.

B. Connections to suit piping.

C. Strainers 6 Inches and Larger: Provide 1-1/2-inch blow-down valve and pipe to floor drain.

D. Strainers 5 Inches and Less: Provide 3/4-inch blow-down valve with hose end connection.

E. Install strainers ahead of all automatic valves, regulating valves and pumps.

3.7 UNIONS

A. Install unions as directed by Fluid Controls Institute, Inc. (FCI).
1. Make connections between couplings and flanged equipment with slip-on flanges.

B. Flanged Connections
1. Where flanged valves are used at equipment connections, flange unions will not be required.
2. Make connections to flanged valves and equipment using ANSI welding neck or slip on type welding flanges.
3. Flanged cast iron ells may be used for connections between pumps, strainers, check valves, and other flanged equipment.

C. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

D. Install dielectric unions or Waterway fittings at each piping joint and equipment connection between ferrous and non-ferrous materials

3.8 DRAINS

A. Provide drain valves to drain all piping systems and drain safety valves.
1. For Draining Low Points of Piping: Minimum 6-inch nipple, with ball valve.
2. On Piping 2-1/2 Inches and Larger: Ball valve with hose adapter.
3. On Piping 2 Inches and Smaller: Ball valve.

B. Drains from Safety Valves
1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap, except where valve drains are required.

D. Drains Piped to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

END OF SECTION 23 2116

SECTION 23 2123

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. See Division 23 Section “Common Work Results for HVAC”.

1.2 DESCRIPTION

A. Work Includes
1. Furnish all labor, materials, tools, equipment, and services for HVAC pumps, as indicated, in accordance with provisions of Contract Documents.
2. Completely coordinate with work of all other trades.
3. Although such work is not specifically indicated, provide all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Description of Systems
1. In-line pumps.

1.3 QUALITY ASSURANCE

A. Standards
1. Hydraulic Institute Standards
2. Hydraulic Institute Engineering Data Handbook.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment item specified.

B. Product Data
1. Pump curves.
2. Performance data.
3. Manufacturer's cut sheets and literature.
4. Materials of construction.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Parts list.
3. Guarantee.

PART 2 - PRODUCTS

2.1 GENERAL

A. Acceptable Manufacturers
   1. In-Line Pumps
      a. Grundfos.
      b. Armstrong.
      c. Aurora.
      d. Goulds.
      e. ITT Bell & Gossett.
      f. Taco, Inc.
   2. Flexible Pump Couplings
      a. Dodge "Para-Flex".
      b. Wood's "Sure-Flex".

B. Pumps and drives shall be made by same manufacturer.

2.2 IN-LINE PUMPS

A. In-line Pumps, Heating and Cooling Water: Centrifugal, closed-coupled, single-stage, bronze fitted, vertical-mount.
   1. Capacity: As scheduled.
   2. Capable of being serviced without disturbing piping connections.
   3. Pump Body: Cast iron with 125 psi ANSI drilled flanges.
      a. Rated working pressure: 175 psi.
      b. Provide with gauge ports.
   4. Impeller: Non-ferrous material, enclosed-type.
      a. Hydraulically and dynamically balanced.
      b. Keyed to shaft and secured by locking capscrew.
   5. Provide internally flushed mechanical seal with ceramic seal seat.
   6. Non-ferrous shaft sleeve to cover wetted area under seal.
   7. Motor: Open drip-proof enclosure with regreasable ball bearings.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all pumps according to manufacturer's recommendations and as specified.

3.2 BASE MOUNTED PUMP INSTALLATION

A. Set floor mounted horizontal pump on concrete base.

B. Level and bolt down.

C. Fill entire base with non-shrinking grout.

D. After pump base grouting is complete, align pump and each driver accurately to provide out of alignment of not over 0.004 inch in both axial and angular planes.

1. After alignment, pin pump and motor to base with taper pins using minimum of 3 pins each.

E. Connect to piping system as indicated.

END OF SECTION 23 2123

SECTION 23 2300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Work Included
   1. Furnish all labor, materials, tools, equipment, and services for the refrigeration piping system as indicated, in accordance with provisions of the Contract Documents.
   2. Completely coordinate with work of all other trades.
   3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Refrigeration Piping System
   1. Refrigeration piping.
   2. Refrigeration valves.
   3. Refrigeration specialties.

1.3 QUALITY ASSURANCE

A. Qualify brazing processes and brazing operators in accordance with ASME, "Boiler and Pressure Vessel Code," Section IX, "Welding & Brazing Qualifications."

B. Regulatory Requirements: Comply with provisions of the following codes:
   1. ANSI B31.5: ASME Code for Pressure Piping -- Refrigerant Piping.
   2. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.
   3. International Mechanical Code.

1.4 SUBMITTALS

A. Shop Drawings: Drawings showing layout of refrigerant piping, specialties and fittings, including, but not limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Before any site work begins, selection data must be submitted to the Engineer showing the refrigerant line loss with the actual condensing unit and coil at condition shown on the schedule sheet of the bid set for all conditions listed on the schedule sheet as well as the manufacturer's recommended DX piping diagram and specialties. Note areas where underground piping enters and leaves underslab conduit.

B. Product Data: Refrigerant pipe “type”.

C. Samples: Not required for review.

D. Project Information: Not required for review.

E. Contract Close-Out Information
1. Brazers' certificates signed by Contractor certifying that Brazers comply with requirements specified under "Quality Assurance" above.
2. Test result reports.
3. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operating & Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:
1. Refrigerant Valves and Specialties
a. Danfoss.
b. Sporlan Valve Co.
c. Emerson Climate Technologies.
d. Henry Technologies.
e. Parker-Hannifin Corp.

2.2 PIPE AND FITTINGS

A. Refrigerant Piping: Copper, dehydrated, with high-temperature soldered joints and wrought copper (400 psig) fittings.
1. For Underground Use: Type K without joints.
2. For Above-Ground Use: Type L, or type ACR with wrought copper fittings and brazed joints. Mechanical fittings (crimp or flare) are not permitted.
3. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in "Cleaning" section.

B. For field assembled units, size refrigeration lines according to manufacturer's published tables using pressure or temperature drops as follows:
1. Suction Lines: 2 deg F.
2. Liquid Lines: 1 deg F or 2 psi.
3. Hot Gas Lines: 1deg F or 3.6 psi.
4. Size discharge and hot gas risers for positive oil return to compressors.

C. Hangers: As specified in Division 23 Section “Hangers and Supports for HVAC Piping and Supports”.
1. Install hangers over outside of insulation.
2. Use copper or cadmium-plated hangers when in direct contact with copper lines.

2.3 SPECIALTIES

A. Moisture Indicator: Show presence of moisture in system by change of color.
1. Install adjacent to filter.
2. In bypass line use Sporlan SA-12S.

B. Strainers: Design to permit removing screen without removing strainer from piping system.
1. Provide with screens of not larger than 80 mesh.

2. Provide strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.

C. Oil Traps: Provide in lines as required.

2.4 VALVES

A. All Valves: All bronze.
1. In Lines 2 Inches and Less: Solder ends.
2. In Lines 3 Inches and Over: Four bolt union ends.

B. Shut Off Valves: Packed type with gas-tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure, or sealed diaphragm type.
1. Wheel, globe, angle or "T" handle.

C. Check Valves
1. In Liquid Lines 5/8 inch and Less: Lift check type.
2. In Lines 3/4 inch-2 inch: Swing check type.
3. In Lines 3 inches and Over: Wafer-type swing check with bronze disc.

D. Expansion Valves: Sized by manufacturer for refrigerant used.
1. Provide one in each circuit with liquid distribution connection immediately.

E. Vent and Test Valves: Angle cap type with seal and outlet caps.

F. Install pressure regulating and relief valves as required by ASHRAE Standard 15.

PART 3 - EXECUTION

3.1 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:
1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
3. Draw a clean, lintless cloth saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
4. Finally, draw a clean, dry lintless cloth through the tube or pipe.

3.2 PIPING INSTALLATION

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 -- "The Safety Code for Mechanical Refrigeration."

B. Install piping for minimum number of joints using as few elbows and other fitting as possible.

C. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

D. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

E. Insulate suction lines. Liquid lines are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.
   1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

F. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

G. Install seamless soft copper tubing in straight length in underground conduit as shown.
   1. Install traps and double risers as required to entrain oil in vertical runs.
   2. Liquid lines may be installed level.

H. Use fittings for all changes in direction and all branch connections.

I. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

J. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

K. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

L. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

M. Locate groups of pipe parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.

O. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

P. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

Q. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

R. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.
   1. Install moisture/liquid indicators in lines larger than 2-1/8-inch OD, using a bypass line.

S. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

T. Install flexible connectors at the inlet and discharge connection of compressors.

3.3 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
   1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
   2. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.

B. During brazing fill the pipe and fittings with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.

C. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

3.4 EQUIPMENT CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow servicing and maintenance.

C. All suction piping not completely concealed underslab or in ceiling cavities shall be rigidly mounted, insulated and covered with PVC jackets.

3.5 TESTING

A. Inspect, test, and perform corrective action for refrigerant piping in accordance with ASME Code B31.5, Chapter VI.

B. Preparation for Testing: Prepare piping in accordance with ASME B31.9 and as follows:
   1. Leave joints, including welds, un-insulated and exposed for examination during the test.
   2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
   3. Isolate equipment that is not to be subjected to the test pressure of the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
   4. Install relief valve set at a pressure to protect against damage by expansion of liquid or other source of overpressure during the test.

C. Testing Procedure
   1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used, if it is safe for workmen and compatible with the piping system components.

2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of that liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
4. All hydrostatic pressure shall be held for a minimum of 6 hours without a loss of pressure.
5. All gravity test shall be held long enough to visually inspect each joint with no visible loss of water for 15 minutes.
6. Air test will be held for a minimum of 2 hours without loss of pressure.
7. Any visible leakage or appreciable pressure drop during the test will be cause for rejection of the test. Additional tests will be required after corrective measures have been taken until satisfactory results are obtained.

D. Testing Requirements

Pipe Leak Testing		
Type of Pipe	Pressure Requirement	Minimum Test Duration
Refrigerant - High side	275 psig dry nitrogen	24 hours
Refrigerant - Low side	150 psig dry nitrogen	24 hours
All other piping test method determined by Superintendent		
* All sewers and drains shall not have more than 100 gallons per inch of nominal diameter per mile of length of either infiltration of exfiltration or as required by USEPA construction requirements under the clean water act.		

E. Testing Records
1. A signed and dated affidavit of testing shall be provided to the Superintendent within 72 hours of completion of testing.
2. Each affidavit shall contain, at a minimum, the testing date, testing start and end time (duration of testing), system or subsystem tested, test medium and pressure, test results, name and signature of individual performing test, name and signature of test witness and whether the portion of pipe tested meets state and local regulations and requirements for leaking.
3. Copies of all affidavits shall be included in the Operation and Maintenance Manuals.

3.6 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems as recommended by equipment manufacturer.

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.7 COMMISSIONING

A. Charge system using the following procedure:

1. Install core in filter dryer after leak test but before evacuation.
2. Evacuate refrigerant system with vacuum pumps; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
5. Break vacuum with refrigerant gas, and allow pressure to build up to 2 psi.
6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

C. Review data in Operating and Maintenance Manuals. Refer to Division 01 Section “Project Closeout”.

D. Schedule training with Owner through the A/E, with at least 7 days’ advance notice.

END OF SECTION 23 2300

SECTION 23 2500

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating and chilled water shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   6. TDS: Maintain a maximum value of 10 ppm.
   7. Ammonia: Maintain a maximum value of 20 ppm.
   8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   9. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
1. Bypass feeders.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for chilled and heating hot water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. J.L. Wingert Co. or equal.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
   1. Capacity: Minimum 3 gal.
   2. Operating Pressure: 150 psi.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   3. Install a swing check on inlet after the isolation valve.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."

E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   4. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

END OF SECTION 23 2500

SECTION 23 3000

DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Description of Systems
   1. Ductwork, fittings, and accessories.
   2. Access doors.
   3. Dampers.
   4. Combination fire/smoke dampers.
   5. Diffusers, registers and grilles.
   6. Pressure relief doors.
   7. Louvers
   8. Duct leakage testing.

B. Work Installed But Not Furnished
   1. Automatic dampers and operators. See Division 23 Section “Controls and Instrumentation”.
   2. Duct-mounted smoke detectors. See Division 26.

C. Definitions
   1. Gage
      a. Steel sheet and wire: U.S. Standard gage
      b. Aluminum sheet: Browne & Sharpe Gage
      c. Steel wire: Washburn and Moen Gage
   2. Concealed Insulated Surfaces: Piping, ductwork and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, sealed alleyways, and above suspended ceilings.
   3. Exposed Insulated Surfaces: Piping, ductwork and equipment located in mechanical rooms, tunnels and rooms without suspended ceilings.

D. Drawings show tentative arrangement of partitions, diffusers and lights.
   1. Owner reserves right to rearrange rooms, lights, and diffusers prior to actual installation to suit his needs.
   2. Final location of diffusers, registers and grilles shall be from architectural reflected ceiling plans.

1.3 QUALITY ASSURANCE

A. Design and Installation Standards
   1. ASHRAE Hand Book – HVAC Systems and Equipment, current chapter on duct construction.

2. ADC Standard 1062: GRD-84, Test Code for Grilles, Registers and Diffusers.
3. ADC Test Code FD 72-R1, Flexible Air Duct Test Code.
4. AMCA Standard 210, Test Code.
5. ASHRAE Standard 70, Method of Testing for Rating Fans for rating performance of Outlets and Inlets.
6. SMACNA HVAC Duct Construction Standard - Metal and Flexible, Third Edition, 2009. [NO EXCEPTIONS]
7. NFPA 90-A, Standard for the Installation of Air Conditioning and Ventilating Systems.
8. International Mechanical Code.
9. ASTM C1071: Microbial growth resistant coatings.

B. Fire and Smoke Rating Test Standards
1. ASTM E84, NFPA 255, and UL 723.

1.4 SUBMITTALS

A. Shop Drawings
1. Ductwork layout at 1/4-inch to 1-foot scale.
2. Indicate dimensions, elevations, clearances, etc.
3. Indicate all equipment, transitions, and fittings to scale.
4. Provide equipment connection details and ductwork support details.
5. Drawings shall be fully coordinated with the work of all other Trades.
6. Any interference that cannot be resolved between the various Trades shall be clearly identified on the Drawings.
7. Contractor shall not fabricate or install ductwork or equipment without approved Shop Drawings.

B. Product Data
1. All product items specified.
2. Manufacturer's literature and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Test, Adjust and balance reports.
3. “As-Built” drawings.
4. Warranties.

1.5 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of ductwork as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

B. See requirements of Division 23 Section “General Mechanical Requirements”.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ductwork: McGill Airflow LLC; Semco, Sheet Metal Products Co.; Tangent Air; Monroe Metal Manufacturing Co.; Spiral-Air; Regional Sheetmetal Manufacturing, LLC and Lindab USA.

B. Duct Sealer: Durkee-Atwood; Hardcast Inc.; McGill Airseal LLC; Foster Products Division; HB Fuller; and Ductmate.

C. Duct Sealing Tape: Durkee-Atwood; Hardcast Inc.; and McGill Airseal LLC.

D. Turning Vanes: Aero-Dyne; Airsan; Hart & Cooley; Titus; Vent Products Co.; and Ductmate.

E. Duct fittings: Buckley, Flexmaster USA, Ins, McGill Air Flow LLC, ACME Mfg.

F. Flexible Fan Connections: Base: Duro-Dyne; Elgin; Ventfabrics; and Ductmate.

G. Flexible Duct: Acme Manufacturing Co.; Flexmaster USA, Inc.; Clevepak Corp.; Clevaflex Division; General Flex Corp.; Flexible Technologies, Automation Industries, Inc.; Flexible Systems Group.

H. Access Doors: Advanced Air, Inc.; Air Balance Inc.; Air Dynamics, Inc.; Greenheck; Prefco Products, Inc.; Ruskin; McGill Airflow LLC; Ventfabrics; Zurn Industries, Inc.; and Ductmate.

I. Manual Dampers: Air Balance, Inc.; Greenheck; Krueger; Pottorff; Prefco Products Inc.; Ruskin Manufacturing Co.; McGill Airflow LLC and Safe-Air Inc.

J. Backdraft Dampers: Air Balance, Inc.; Greenheck; Cesco; Pottorff; Prefco Products Inc.; Ruskin Manufacturing Co.; and Safe-Air Inc.

K. Fire and Combination Fire/Smoke Dampers: Pottorff; Greenheck; Air Balance, Inc.; Ruskin Manufacturing Co.; Arrow United Industries, Inc.; Prefco Products; Safe-Air Inc.

L. Diffusers, Registers, and Grilles: Anemostat; Krueger; Titus; and Price.

M. Pressure Relief Doors: Ruskin, Green Heck, Pottorff, KEES, AJ Manufacturing, Inc.

2.2 MATERIALS—GENERAL

A. Sheet Metal
   1. Galvanized Steel: ASTM A93, A924, A653, F.S. QQ-I-716

B. Duct Sealer
   1. NFPA rating of "Non-Combustible."
   2. Flame Spread Rating: 25 or lower, in dry condition.
   3. Smoke Developed Rating: 50 or lower, in dry condition.
   4. Resistant to water and water vapors.
   5. Pressure Rupture Rating: 16-in. water gauge, minimum.
   6. Durkee-Atwood, Permatite Class I; Hardcast 601; or United McGill, Uni-Grip Duct Sealer.

C. Flexible Ducts
   1. UL 181, 191
   2. NFPA 90A and 90B

D. Solder: ASTM B23, Grade 50B or F.S. QQ-S-571, Composition Sn50.

E. Duct Sealing Tape
   1. NFPA rating of "Non-Combustible."
   2. Flame Spread Rating: 25 or lower, in dry condition.
   3. Smoke Developed Rating: 50 or lower, in dry condition.
   4. Adhesive: Specifically compounded for adhesion to galvanize and stainless steel.
   5. Tape to be UL listed.

F. RTV Foam: UL-listed room temperature vulcanized silicone rubber foam.

G. Acoustical Duct Liner (as noted)
   1. Knauf, Certain Teed Corp., Owens-Corning, Manville or Manson.

2.3 DUCTWORK, FITTINGS, AND ACCESSORIES

A. Ductwork - General
   1. Constructed of galvanized steel sheet not less than 24 gauge.
      a. Maintain full areas and suitable shapes at all points.
      b. Shapes may be changed to fit unusual space conditions.
      c. Provide all necessary transitions and offsets to complete systems.
   2. Each duct system shall be constructed for the specific external static pressures shown on the Contract Drawings.

B. Ductwork, under 4 in wg (water gauge), Sheet Metal
   1. Ductwork includes but is not limited to:
      a. All ductwork on outlet side of air terminal units and air pressure reducing valves.
      b. Parts of return, exhaust and relief air ductwork as indicated.
   2. Construct in accord with SMACNA HVAC Duct Construction Standard as follows:
      a. Rectangular duct: Table 2-5 or 2-19, positive or negative.
      b. Round duct: 10 in wg static pressure Table 3-5, positive or Table 3-13 negative.
      c. Round ducts shall be spiral seam.
   3. For all ducts with longest side 24 inches and over: Construct using the Ductmate, Nexus, Quicduc, SMACNA T-24 flange, or Pyramid-Lok duct connection systems.
      a. Seal flanged ends with pressure-sensitive, high-density, closed-cell neoprene or polyurethane tape gasket, "Tremco 440", or butyl gasket.
      b. For smaller duct sizes (longest side 23 inches or less): Above systems are optional.
   4. Seal all ducts based on external static pressures. For external static pressures below 1.5 in wg seal to meet SMACNA Seal Class B for 2 in wg as a minimum. For external static pressures below 4 in wg seal to meet SMACNA Seal Class A for 10 in wg as a minimum.
   5. Runouts to Diffusers, Register and Grilles: May use flexible ducts.
      a. Exception: Flexible ducts may not pass through smoke or fire-rated walls, floors, or ceilings.
      b. Maximum flexible duct length: 5 ft.
      c. Minimum turning radius: As recommended by manufacturer.

C. Ductwork, 4-inch wg and Over
   1. Ductwork includes:
      a. All supply ductwork from air handling unit discharge to connection with air terminal units and air pressure reducing valves.
      b. Rectangular supply, return, and exhaust duct operating in (positive or negative) pressure.
   2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
      a. Rectangular duct: Table 2-7 or 2-21, 10 in wg static pressure, positive or negative.
      b. Round duct: Table 3-5 10 in wg positive static pressure. Table 3-13, 10 in wg negative static pressure.
      c. Flat oval duct: Table 3-15, 10 in wg static pressure.
      d. Round and flat oval ducts to be spiral lockseam constructed.
   3. Runouts to Air Terminal Units: Rigid or flexible ductwork.
      a. Exception: Flexible ducts may not pass through smoke or fire-rated walls, floors, or ceilings.
      b. Maximum flexible duct length: 3 feet.
      c. Minimum turning radius: As recommended by manufacturer.
   4. Seal all ducts to seal Class A requirements.

D. Aluminum Ductwork
   1. Use aluminum ductwork for systems as noted on drawings.
   2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
      a. Type 3003-H14, conforming to ASTM B-209.
      b. Use Table 2-50 to convert galvanized steel gauges required in paragraphs above, to comparable aluminum thicknesses.
      c. Use Table 2-51 and Table 2-52 and notes for how to adapt the steel duct reinforcement required in paragraphs above, to comparable aluminum reinforcement.
   3. Duct joints shall be all-soldered construction.
   4. Provide only fastners, hangers, turning vanes, access doors, taps, fittings, dampers, insulation, supports, reinforcing, and accessories that are fully compatible with aluminum.

E. Duct Hangers and Supports
   1. In accordance with the following:
      a. Ductwork (Sheet Metal): SMACNA HVAC Duct Construction Standard, Chapter 5.

F. Duct Fitting and Joints under 4-Inch wg
   1. Radius Elbows Without Vanes: Radius ratio (R/W) of 1.5 and greater.
      a. Radius ratio (R/W) less than 1.5 are not allowed.
   2. Where square throat elbows are indicated or required, provide with turning vanes.
   3. Connections to Diffusers, Grilles and Registers: Fitted securely to necks or collars provided behind diffuser, grille, or register face area.
   4. Branch Connections
      a. Round: Factory-built bellmouth-type with locking quadrant damper.
      b. Rectangular: 45-degree entry type or radius elbow.
   5. Provide all necessary transition pieces and duct collars to make connections to ductwork from neck sizes scheduled or shown on Drawings.

6. Where building walls, floor and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted to building structure.

G. Duct Fittings and Joints on Systems 4 in-Inch wg and Over
1. Elbows 3- through 12-Inch Diameter: Die-stamped, for minimum air friction loss, with continuous corrosion-resistant welds.
2. Elbows over 12 Inch Diameter: Welded segment-type or standing seam, not less than 5 pieces for 90-degree elbows, and not less than 3 pieces for 45-degree elbows, using corrosion-resistant welds.
3. Tees: "Low loss, short cone-type," unless specifically detailed otherwise for space limitations.
4. "Y"s 45-degree type; 60-degree type may be used if space conditions dictate.
5. Install "Y"s where indicated.
6. Where tees are indicated, "Y"s may be substituted if space is available.
7. "Y"s: Straight-sided-type (no cone).
8. Take-Offs from Air Handling Unit Plenums: Bellmouth fittings.
9. "Y" take-offs from horizontal ceiling mounted ducts to serve boxes: May be straight-sided, shop-fabricated-type by accurately cutting and welding "Y"s into spiral ducts without use of fittings.

H. Turning Vanes
1. For square-throat elbows.
2. Velocities up to 2500 fpm: Single-vane, runner Type 2, with 3/4-inch trailing edge, 2-inch vane radius, and 1-1/2-inch vane spacing, minimum 24-ga.
   a. For widths over 36 inches install vanes in 2 or more sections or use tie rods to limit unbraced vane length.
3. Where inlet and outlet dimensions of elbows are not equal, set 2 or more sections at 45-degree angle to give optimum turning as detailed on sheet metal drawings.

I. Partitions and Blank-Off Plates
1. Where used as part of an air handling unit, construct of 14-ga sheet metal with 1-1/2-inch standing seams.
2. Partitions 8 feet long or less: Use 1-1/2 x 1/4-inch angles spaced 2 feet on centers for additional bracing.
3. Partitions over 8 feet long: Use 2 x 1/4-inch angles.

J. Flexible Fan Connections
1. Material: Minimum 30 ounce Neoprene double-coated closely woven glass fabric flexible connections.
2. Fasten fabric to sheet metal duct work and to fan collar extension with 3/16-inch rivets spaced not more than 5 inch on center.
3. Locate in inlet and outlet of all fans, as close to fan as possible.
4. Provide at all ducts crossing building expansion joints and where indicated on drawings.
5. Connections shall not be under tension.
6. Isolate duct system from all equipment by at least 1 inch.

K. Flexible Ducts, Preinsulated
1. Under 4 inch wg Construction
   a. Spiral wire or band, reinforced fabric liner or flexible aluminum or galvanized steel duct.

b. Nominal 1 inch x 3/4 lb/cf fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.

2. 4 inch wg and Over Construction
   a. Spiral wire or band, reinforced fabric liner or 2-ply flexible aluminum or hot-dip galvanized duct.
   b. Nominal 1inch x 3/4 lb/cf fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.
3. Rated Working Pressure
   a. Under 4 in wg duct: 5 inches positive or negative.
   b. 4 inch wg and over duct: 10 inches positive.
4. Fire-resistant, self-extinguishing, UL Standard 181, Class 1, with flame spread of 25 or less and smoke development not to exceed 50.
5. R value – 6.0 unconditioned spaces, 4.2 conditioned spaces.
6. Under 4 inch wg Connections
   a. Secure non-metallic duct to collar or sleeve with nylon draw band.
   b. Secure metallic duct (under 12 inches in diameter) to collar with minimum three #8 sheet metal screws equally spaced around the duct's circumference. For ducts 12 inches in diameter and over use minimum five #8 sheet metal screws.
7. 4 inch wg and over Connections
   a. Secure duct to collar or sleeve with duct sealer and 1/2-inch aluminum or galvanized steel bands or clamps.
   b. Secure insulation jacket with 2 wraps of duct tape.
8. Insulation and vapor barrier on factory-fabricated ducts shall be fitted over the core connection and shall also be secured with a draw band.
9. Duct Sealer: E Moore Co., Tuff-Bond No. 12; Benjamin Foster No. 30-02, or McGill Airseal.
10. Turn Radius: Not less than R/D equal to 1.0.
11. Provide flexible duct supports in accord with Figure 3-10 and 3-11, SMACNA HVAC Duct Construction Standards.
12. FLEXIBLE DUCTS SHALL NOT BE USED FOR RETURN OR EXHAUST.

L. Access Doors
1. Provide at all fire, smoke, or duct-mounted dampers and where indicated.
2. Doors shall close with air pressure, and shall have latches and hinges.
3. Provide doors with 2-inch extension necks to clear insulation where applicable.
4. Install all doors to permit easy visual inspection of fire or smoke dampers.
5. Hardware: Ventlok, or equal, as follows:
   a. Doors up to 12-inch maximum, in any direction: One No. 100.
   b. Doors up to 18 inch long: Two No. 140 or No. 205.
   c. Doors up to 24 inch long: Two No. 260.
   d. Doors over 24 inch long: Two or more No. 310.
   e. Door handles: Ventlok 220
6. Provide gasket seal on all access doors.

2.4 DAMPERS

A. Dampers - General
1. Sizes and Types: As indicated.
2. Locate where indicated.
3. Factory-built and -assembled dampers.

B. Dampers, Automatic-Control-Type
   1. Furnished in Division 23 Section “Controls and Instrumentation”.
   2. Install as specified in this Section.

C. Dampers, Manual (Rectangular and Square)
   1. Opposed-blade-type, fitted with shank bolts, marked for direction (open/closed).
   2. Provide for double-socket wrenches to fit square shank and locking hex nut.
   3. Construction: Heavy minimum 12-gauge galvanized steel frames, flat or angle iron, with blades of 16-ga galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.

D. Damper, Manual (Round)
   1. Butterfly-type with circular blade mounted to shaft.
   2. Frame: Minimum 14-ga galvanized steel channel.
   3. Blade: Minimum 16-ga galvanized steel.
   4. Axle: 1/2-inch diameter.
   5. Bearings: Self-lubricating nylon or stainless steel sleeve.

E. Dampers, Backdraft, under 4 inch wg
   1. Counterbalanced, gravity-operated.
   2. Fabricate of aluminum.
   3. Blades: Provided with common linkage rod and felt seals.

2.5 COMBINATION FIRE/SMOKE DAMPERS

A. Parallel blade type with all blades hinged together for operation in unison and bearings arranged for automatic operation.

B. May be used in lieu of separate dampers in low pressure systems for normally closed operation.

C. Static Pressure Loss: Not over 0.25 inch WG at 2000 fpm and 24 inches x 24 inches.

D. Use oversized dampers where necessary.

E. Fire Rating: UL labeled for 1-1/2 hour.

F. UL 555S Leakage Class: I (8 cfm/ft^2 at 4 inch WG).

G. Firestat: UL listed.
   1. Lock damper in closed position at 212 deg F duct temperature.
   2. Provide override function to operate damper in a smoke control operation.
   3. Provide two damper position indicator switches to provide remote indicating damper position

H. Operator: Electric motor mounted on exterior of damper sleeve.

2.6 FIRE DAMPERS

A. Fire Dampers - General
   1. UL-labeled, 1-1/2-hr.-rated, unless otherwise indicated.
   2. Provide where indicated and where required by NFPA and local regulations.

3. Provide with mounting angles and minimum 18 -gauge sleeves.
4. Fusible link temperature rating to be per NFPA 90A (approximately 50 deg F above operating temperature but not less than 212 deg F and not to exceed 286 deg F).
5. All dampers to be dynamic rated.

B. Fire Dampers in Ducts under 4 inch wg (Passing through 2-Hour-Rated Walls)
1. Multi-blade for openings over 12 x 12 inches, single-blade for openings 12 x 12 inch and less.
2. Multi-blade dampers: All blades must be out of airstream.
3. In small ducts, 8 inch and less: 1 inch larger in each dimension to give total loss through damper of 0.10 inch WG or less.
4. Air Balance, Inc., Model 119; Ruskin Model IBD; Greenheck DFD150.

C. Fire Dampers in Ducts 4in wg and over (Passing through 2-Hour-Rated Walls)
1. With sleeve and adapter fittings on each side of sleeve.
2. Air Balance, Inc., Model 119; Ruskin Model IBD; Greenheck DFD150.

2.7 DIFFUSERS, REGISTERS, AND GRILLES

A. Diffusers, Ceiling
1. Square-type or slot-type as indicated.
2. Size, Type, and Manufacturer: As scheduled.
3. Finish: Factory-applied, baked or electrocoated enamel; color as selected by A/E or as indicated.
4. Sponge rubber gasketed for ceiling diffusers and supply registers.
5. Provide all necessary screws, duct collars, transitions and air pattern deflectors.
6. Paint interior of perforated supply and return diffusers flat black. Exterior surfaces to mach ceiling color, of factory enamel finish.
7. Use nominal 24-x 24-inch panel style diffusers in areas with lay in ceilings.
8. For hard ceilings, use 12- x 12-inch face diffusers with overlap style mounting for 6-inch diameter neck sizes; and 24- x 24-inch face for neck sizes 8 inches and larger.
9. Use circular diffusers in areas where ductwork is exposed only where indicated.
10. For all Supply Air devices, provide with molded insulation blanket/insulated backpan unless noted otherwise.
11. Provide opposed-blade dampers where scheduled on the Drawings.
12. Provide easily removed inner core with a positive lock.

B. Air Grilles and Registers
1. Size, Type, and Manufacturer: As scheduled.
2. Finish: Factory-applied, baked or electrocoated enamel; color as selected by A/E or as indicated.
3. Sponge rubber gasketed for ceiling and wall supply units.
4. Provide all necessary screws, duct collars, and transitions.
5. Provide opposed blade dampers with supply air grilles and registers where scheduled on the Drawings.

C. Diffusers and Grilles, Linear
1. Size, Type, and Manufacturer: As scheduled
2. Adjustable pattern, extruded aluminum or steel.
3. Fixed pattern, extruded aluminum, airline grille with 0-degree deflection, and damper.

4. Fixed pattern, extruded aluminum, airline grille with 15-degree deflection, and damper.

2.8 PRESSURE RELIEF DOORS

A. Provide pressure relief doors to relieve pressure and prevent structural damage to ductwork or plenums in the event excessive pressure within the air distribution systems should occur. Provide in the supply and return air paths of air handling units.

B. Doors to open at 8 inches wg static on supply systems and -4 inches wg on return systems.

C. Doors to automatically close and reset when the static pressure is reduced to less than 4 inches wg on supply systems and -2 inches wg on return systems

D. Doors to be installed to open outwardly to relieve positive pressure build-up or to open inwardly to prevent damage due to negative pressure.

E. Construction
1. 12-ga galvanized steel frame and door.
2. Polyurethane foam seal around door perimeter.
3. Negator springs for door closure upon loss of over-pressurization.
4. 18 x 18 inch size.

F. Ruskin PRD18 pressure relief door.

G. Install vertically and level for proper operation.

2.9 LOUVERS

A. Acceptable louver manufacturers are Greenheck, Ruskin, and Construction Specialties. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect. Factory color samples shall be submitted with shop drawings.
1. Louvers shall be drainable blade with vertical downspouts in louver jambs, extruded aluminum with anodized finished, channel frame with concealed mullions with birdscreen.
2. Louvers shall have a minimum of 50% free area.

2.10 DUCT LEAKAGE TESTING

A. For ducts constructed for 4-incg wg and above:

B. Use procedures listed in the “HVAC Air Duct Leakage Test Manual”.

C. Provide a report to the Engineer of the findings of the duct leakage test.

D. Coordinate testing with the Commissioning Agent and Construction Manager.

PART 3 - EXECUTION

3.1 GENERAL

A. Form and erect ductwork to avoid pipes, lighting fixtures, joists, beams, etc., and to maintain head room and clearances required for the project, or as noted. Coordinate locations with work of all Trade Contractors. Verify all dimensions and elevations. Special attention is again directed to the pre-construction layout drawing and coordination requirements of this section.

B. Provide all offsets and modifications to the duct systems required because of interferences encountered. It is this Contractor's responsibility to avoid this as much as possible by coordinating his work with the work of the other Contractors. If modifications are necessary, this Contractor shall perform all such modifications and offsets in an approved manner as required for this work, at no additional cost.

C. Volume dampers or splitter dampers shall operate without rubbing side of ducts or binding. Blades shall be tight on shaft. If dampers are loose and noisy, system will be rejected and damper shall be replaced.

D. Only one damper regulator will be allowed per multi-blade damper. All multi-blade dampers shall be provided with Vent Fabrics, Inc. parallel blade and opposed blade hardware. Dampers shall be set in a 3/8-inch x 2-inch steel frame.

E. If, because of obstructions, damper regulation is not possible with the above hardware, regulation shall be accomplished with right angle gear assemblies. Dampers in concealed ductwork shall be operable at concealed regulators.

F. Provide concealed regulators for volume dampers in concealed ductwork.

G. Paint inside surface of ductwork for a distance of two feet directly behind air devices, with flat black where sheet metal is visible.

3.2 INSTALLATION OF DUCTWORK

A. Install ductwork in accordance with arrangements and sizes indicated on the Drawings; construct of the best grade of galvanized steel unless otherwise specified. Include all necessary elbows or square turns with turning vanes of the double-wall galvanized steel air-foil-type, deflectors, dampers, damper quadrants, hangers, etc., and erect in a thorough and workmanlike manner. Rectangular ducts of 14-inch size dimensions and under, and round and oval ducts, shall have radius turns, with inside radius equal to or greater than the dimension of duct in direction of turn, in lieu of turning vanes.

B. Conceal all ductwork in finished spaces unless indicated otherwise.

C. All ductwork exposed to view shall be supplied and installed with paint grip galvanizing with final painting of same by the painting Trade Contractor. Painting shall not be a part of this Contractor's work. Do not paint ceiling-hung ductwork in electrical equipment rooms or sensitive production areas and switchrooms.

D. Form radius elbows with a 1-1/2 ratio of centerline radius of duct dimension in the direction of the turn wherever possible.

E. Do not install ductwork in or allow to enter or pass through electrical rooms, elevator machine rooms, or spaces housing switchboards, panelboards or distribution boards, except ductwork that serves electrical rooms, elevator machine rooms, or spaces.

F. Exercise special care to provide tight-fitting well-fabricated, well-braced ductwork systems.

G. Field assembly rectangular, round or flat oval ductwork as follows:
1. Use caulking-grade joint sealer applied slip joints, or:
2. Use slip joints, couplings, etc., sealed with "shrink-fit" plastic bands, with thermal setting adhesives pre-applied to plastic bands, or:
3. Use slip joints, couplings, etc., sealed with pressure-sensitive tape.
4. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets, and gaskets and washers for bolts.

H. In ducts 4-inch wg and over ductwork, do not use 2-piece mitered 90-degree elbows with or without vanes unless approved by Engineer.

I. Make all duct connections from hoods, openings, fans, and other devices.

3.3 INSTALLATION COMBINATION FIRE/SMOKE DAMPERS

A. Install in accordance with manufacturer's instructions as well as all applicable codes.

B. Seal all dampers at wall openings and between damper and sleeve or duct around one side of damper's downstream face.

C. 24 volt AC power supply by Electrical Contractor.

3.4 CLEANING

A. At completion of work and prior to final acceptance, clean all work installed under this Section.

3.5 EQUIPMENT DEMONSTRATION

A. Prior to final acceptance, inspect, test, and operate satisfactorily, in presence of Engineer and representative of the Owner, operation of each piece of equipment and its accessories.

B. If inspection or test shows defects, replace defective work or material.

C. Repeat inspections and tests until defects are eliminated.

END OF SECTION 23 3000

SECTION 23 3400

EXHAUST AND VENTILATING FANS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. DESCRIPTION OF SYSTEMS
1. In-line centrifugal and mixed flow fans.

B. ABBREVIATIONS
1. AMCA: Air Moving and Conditioning Association.
2. ADC: Air Diffusion Council.
3. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.

1.3 QUALITY ASSURANCE STANDARDS

1. ADC Standard 1062R2, Air Diffusing Equipment Test Code.
2. AMCA Standard 210, Test Code for Air Moving Devices.
3. ASHRAE Standard 70, Method of Testing and Rating the Air Flow Performance of Outlets and Inlets.
4. NFPA 90-A, Standard for the Installation of Air Conditioning and Ventilating Systems.
5. UL listed as “Power Ventilator for Smoke Control Systems” (where applicable).

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

B. Shop Drawings: All equipment items specified, including fan curves.

C. Product Data
1. Dimensional Drawing.
2. Performance data.
3. Fan curves for specific operation, with flow, static pressure, and horse power.
4. Sound data

D. Contract Close-Out Information
1. Operating and maintenance data.
2. Owner instruction report.

E. ACCEPTABLE MANUFACTURES
1. Greenheck Fan Corp., Acme, Penn, Loren Cook.

PART 2 - PRODUCTS

2.1 GENERAL

A. Fans - General
1. Performance ratings: Based on laboratory tests conducted in accordance with latest edition of the ASHRAE/AMCA Standard Test Codes. All fans to be AMCA labeled.
2. Ratings: As indicated.
3. Arrangement and drive: As indicated.
4. Provide removable belt guard.
5. Drive sheaves
   a. Cast iron, split tapered bushings dynamically balanced at factory.
   b. Provide wide-range variable-speed adjustable sheaves to be used for balancing systems.
   c. Provide final fixed pitch drive sheaves for proper RPM determined during balancing process.
6. Fans 15 HP and less: Provide with adjustable sheaves.
7. Finish: Applied or as indicated on Drawings.
8. For fans suspended from ceilings, belt-tightening device may be pivoted-type.

2.2 IN-LINE CENTRIFUGAL FANS

A. In-Line Centrifugal Fans
1. Centrifugal, direct or belt-driven.
2. Capacity: As scheduled.
3. Fan wheel: Backward-inclined or Forward curved, dynamically and statically balanced
4. Electronically Commutated Motor
   a. Motor enclosures: Open type.
   b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
   c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
5. Shafts and Bearings:
   a. Fan shaft shall be ground and polished solid steel with an anti corrosive coating.
   b. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours equlent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
   c. Bearings are 100 percent factory tested.
   d. Fan Shaft first critical speed is at least 25 percent over maximum operating speed.
7. Housing/Cabinet Construction
   a. Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.
   b. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.
8. Options/Accessories

a. Provide factory-installed and -wired disconnect device outside motor compartment.
b. Provide powered, Inlet Vane, or self-acting backdraft damper.
c. Belt Guards to cover motor and drive.
d. Inlet and/or Outlet guard.
e. Factory isolation – free standing or housed Neoprene/rubber/spring sized for weight of the fan.
f. Motor mounted potentiometer dial or Factory-wired, solid-state speed controller, on direct-drive fans.
g. Extended lube lines.
h. Explosion-Proof Units: Provide spark-proof, non-ferrous wheels, spark-proof belt, with explosion-proof motor in separate compartment, arranged for explosive vapor exhaust.
i. Finishes as scheduled.
j. Factor provided Variable Frequency Drives as scheduled.
k. Insulated housing.
l. Integral light – for ceiling application.
m. Additional control and venting accessories to be scheduled.

2.3 MIXED FLOW INLINE FANS

A. Mixed Flow Inline Fans
1. General
a. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
b. Fans are to be equipped with lifting lugs.
c. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.
2. Housing and Outlet
a. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
b. All mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge
c. Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Bearing life shall not be reduced below specified level in different configurations. Units size 30 and larger shall allow for field rotation of motor positions. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.
d. An access door shall be supplied for impeller inspection and service.
e. OSHA compliant belt guard or motor cover to be included to completely cover the motor pulley and belt(s).
3. Fan Impeller
a. Fan impeller shall be mixed flow design. The impeller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
4. Shaft and Bearings
a. Fan shaft shall be ground and polished solid steel with an anti-corrosive coating
b. Fan shaft first critical speed is at least 25 percent over maximum operating speed

c. Bearings shall be air handling quality, regreaseable pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
d. Bearings shall have extended lubrication lines with Zerk fittings to allow for lubrication

PART 3 - EXECUTION

A. INSTALLATION
1. Install in accord with manufacturer's recommendations and as specified.
2. All roof-mounted fans are to have their curb caps secured to the roof curbs.

B. FAN DYNAMIC BALANCING
1. Have fan dynamic balancing for 7.5 hp and above centrifugal fans performed by experience trained mechanics from factory to include following:
2. Inspection of fans to determine if damage has occurred during storage or installation and coordinate repair of any damages.
3. Inspection of fan drives, including bearing and motor mounts.
4. Inspection of tensioning of drive belts on adjustable and fixed pitch sheaves.
5. X-Y dynamic vibration plot on each fan resulting in a properly balanced installation within factory specifications, performed after system has been balanced and final fixed pitch drive sheaves installed.

END OF SECTION 23 3400

SECTION 23 3401

KITCHEN HOOD EXHAUST SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Provide a completely factory packaged, self-contained kitchen exhaust hood with automatic detergent wash-down cleaning system and integral fire protection system.

B. Coordinate the exact location of the hood with the work of other trades prior to fabrication and/or installation. Verify all dimensions and elevations.

C. Provide hood complete with controls for activating the make-up air unit and the kitchen hood exhaust fan.

1.3 QUALITY ASSURANCE

A. Hood shall be recommended for applications that require high grease extracting efficiencies. Hood shall be of the type approved and recommended for use over all types of cooking equipment such as griddles, charbroilers, ovens, upright broilers, fryers, and ranges.

B. Hood shall be manufactured in compliance with, or approved by, the following: National Fire Protection Association (NFPA) Bulletin #96, Underwriters' Laboratories (UL) Test Procedure #710 (UL listed with or with fire damper), National Sanitation Foundation (NSF), and B.O.C.A.

1.4 SUBMITTALS

A. Shop Drawings
   1. Detail Fabrication Drawing indicating dimensions, materials of construction, features, connections, field required piping, supports, and detailed installation instructions.
   2. Layout hood on Sheetmetal Fabrication Drawings showing all connections.

B. Product Data
   1. Manufacturer's cut sheet
   2. Performance data, including air flow rates and associated pressure drops.
   3. Wiring diagrams.

C. Samples: Not required for review.

D. Reference Submittal: Not required for review.

E. Contract Closeout Information
   1. Operating and maintenance data.
   2. Warranties.

PART 2 - PRODUCTS

2.1 KITCHEN EXHAUST HOOD

A. Wall-mounted, canopy type hood.

B. UL listed without exhaust fire dampers.

C. Type 430 stainless steel on all exposed surfaces. Joints and seams to be continuously welded liquid tight and all exposed external welds are to be ground and polished to match the original finish of the metal.

D. Hood shall include full-length, horizontal baffles to create high velocity centrifugal grease extraction. Non gasketed inspection doors shall provide full length access to each grease extraction plenum.

E. Supply Plenum: The supply plenum shall be fully lined with UL-recognized, 1 inch thick, 5# density, foil backed insulation, with all ends and seams tightly covered with foil-backed tape. A perforated metal diffuser plate shall be supplied to ensure even air distribution over the entire length of the supply plenum.

F. Hood shall be equipped with recessed, twin tube, UL listed fluorescent light fixtures. Lights shall be prewired through a concealed conduit terminating at a junction box located atop the hood. All electrical wiring and plumbing shall conform to national and local code requirements.

G. Provide a prewired remote mounted control center to activate the make-up air unit and the hood exhaust fan.
1. A door interlocking disconnect switch.
2. Magnetic motor starters with thermal overloads and manual reset.
3. 120 volt control transformer.
4. Fuse blocks.
5. Terminal strips.
6. NEMA 3R cabinet constructed of 18-ga galvanized steel.

2.2 FIRE SUPPRESSION SYSTEM

A. The hood shall contain a factory engineered and pre-piped, UL listed, wet chemical, Ansul R-102 fire suppression system. The system piping shall be installed in the hood at the time of construction by the hood manufacturer. Piping shall be installed above the hood or within the supply plenum and shall be concealed from view. No exposed piping is acceptable, with the exception of appliance drops. A certified local Ansul distributor shall be selected by the factory for final system hook-up. The hood manufacturer shall be responsible for the coordination between the contractor and the Ansul distributor for the final field hook-up and certification of the fire suppression system.

B. The system shall be capable of automatic detection and actuation and/or remote manual actuation. The system shall have the fire suppression capabilities to protect the duct(s), plenum(s), filter area(s), and cooking equipment. Accessories shall be available for mechanical or electrical gas line shut-off applications and a double-pole, double-throw micro switch for activation of a shunt trip breaker (provided by others) for electrical equipment. The system shall also include the release assembly, agent tank, detectors, fusible links, liquid-tights fittings,

remote manual pull station, and Schedule 40 black iron pipe with chrome sleeving for exposed areas.

C. A cabinet shall be furnished to contain the release assembly and agent tanks. This cabinet shall be manufactured of the same material as the hood.

2.3 ACCEPTABLE MANUFACTURERS

A. Greenheck, Gaylord.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with latest issued manufacturer's published instructions and all applicable inspection and code authority requirements.

B. Verify applicable voltage, phase, and protective device requirements with electrical contractor before manufacture or installation of equipment.

C. Exhaust Air: Exhaust air shall be based on 1.25 inch static pressure for hood and filters plus duct and fan discharge resistances.

D. Make-up Air: Tempered air shall be provided based on 0.25 inch available static pressure at hood inlet connection.

E. Other Requirements: Provide cold water, hot water, and 120 VAC to control panel and plumbing enclosure. Provide 2-inch drain on each side of the hood. Refer to application sizing charts and wiring diagrams of manufacturer for detailed information.

3.2 DUCTWORK

A. Duct shall be constructed of 16 gauge carbon steel with liquid-tight continuous weld of all seams and joints. Inside laps on duct joints shall project in a direction against the air flow.

B. Ducts shall be so constructed and sloped ¼” per 1’-0” towards the hood as to provide suitable drainage of grease.

C. Hand holes for inspection and cleaning purposes, equipped with tight fitting sliding or swinging doors and latches, shall be provided in horizontal sections of exhaust ducts. Such openings shall be at the sides of the horizontal run to prevent dripping of residue. Spacing of such openings shall not exceed 20 feet and shall be located at all offsets. Openings shall have a minimum dimension of 20" in width with a height equivalent to the duct height minus one inch.

D. The Contractor shall install the kitchen rangehood exhaust duct systems and maintain the minimum code required clearances to combustibles. The use of UL listed and approved enclosure system of fire wraps/blankets installed per the manufacturer’s instructions are acceptable when required to achieve the clearance to combustibles requirements.

E. At the Contractor's option, a UL 1978 listed, Pre-manufactured Duct System equal to Metal Fab 3G shall be acceptable. Duct shall have a stainless steel inner liner, aluminized outer liner and one or three inch liner as required to comply with requirements of clearance to combustibles.

F. Shop drawings of the kitchen rangehood exhaust ductwork shall be made and submitted to the appropriate reviewing agency. Any fees associated with this submittal shall be borne by this Contractor.

END OF SECTION 23 34 01

SECTION 233500

REFRIGERANT DETECTION AND ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant monitors, notification appliances, and equipment.

1.3 DEFINITIONS

A. LCD: Liquid-crystal display.

B. LED: Light-emitting diode.

C. MOS: Metal-oxide semiconductor.

D. NDIR: Non-dispersive infrared.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of refrigerant monitor, include refrigerant sensing range in ppm, temperature and humidity range, alarm outputs, display range, furnished specialties, installation requirements, and electric power requirement.

B. Shop Drawings:

1. Air-Sampling Tubing: Size, routing, and termination including elevation above finished floor.
2. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Include machinery-room layout showing location of monitoring devices and air-sampling tubing with filter/inlet locations in relation to refrigerant equipment.

B. Product Certificates: For monitoring devices, signed by product manufacturer.

C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant monitoring equipment to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. One calibration kit including clean air calibration gas bottle for zero calibration and specific refrigerant calibration gas for span calibration, minimum 58-L capacity, pressure regulator, and tubing.

1.8 COORDINATION

A. Coordinate refrigerant detection and alarm system with refrigerant contained in refrigeration equipment for compatibility.

PART 2 - PRODUCTS

2.1 NDIR REFRIGERANT MONITOR

A. Description: Sensor shall be factory tested, calibrated, and certified to continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, shutting down fuel-fired equipment, and automatically activating ventilation system.

B. ASHRAE: Monitoring system shall comply with ASHRAE 15.

C. Performance:

1. Refrigerant to Be Monitored: R-123, R-134a, R-410A.
2. Range: 0 to 1000 ppm.
3. Sensitivity:

a. Minimum Detectability: 10 ppm.
b. Accuracy: 0 to 100 ppm; plus or minus 10 ppm. 100 to 1000 ppm; plus or minus 10 percent of reading.
c. Repeatability: Plus or minus 1 percent of full scale.
d. Response: Maximum 10 seconds per sample.
e. Detection Level Set Points:

1) Detection Level 1: 1 ppm.
2) Detection Level 2: 10 ppm.
3) Detection Level 3: 50ppm.

4. Sensitivity:

a. Minimum Detectability: 20 ppm.
b. Accuracy: 0 to 100 ppm; plus or minus 20 ppm, 100 to 1000 ppm; plus or minus 5 percent of reading.
c. Repeatability: Plus or minus 1 percent of full scale.
d. Response: 50 percent of a step change in 60 seconds.
e. Detection Level Set Points:

1) Detection Level 1: 20 ppm.
2) Detection Level 2: 50 ppm.
3) Detection Level 3: 250 ppm.

5. Operating Temperature: 32 to 104 deg F.
6. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range. Compensate sensor for relative humidity.
7. Site Elevation: Maximum 6560 feet.

D. Input/Output Features:

1. Maximum Power Input: 120-V ac, 60 Hz, 75 W.
2. Number of Air-Sampling Points: Four.
3. Air-Sampling Point Inlet Filter: 0.10-micron filter element for each sampling point.
4. Air-Sampling Point Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms matched to sensor output.
5. Alarm Relays: Minimum 4 relays at a minimum of 5-A resistive load each.
6. Alarm Set Points: Displayed on front of meter and adjustable through keypad on front of meter.
7. Alarm Acknowledge Switch: Mount in the front panel of the monitor to stop audible and visual notification appliances, but alarm LED remains illuminated.
8. Alarm Manual Reset: Momentary-contact push button in the front panel of the monitor stops audible and visual notification appliances, extinguishes alarm LED, and returns monitor to detection mode at current detection levels.
9. Display: Alphanumeric LCD, LED indicating lights for each detection level; acknowledge switch and test switch mounted on front panel; alarm status LEDs and service fault LEDs.
10. Audible Output: Minimum 75 dB at 10 feet.
11. Visible Output: Strobe light.
12. Sensor Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms.
13. Serial Output: RS-232 or RS-485 compatible with HVAC controls.
14. Enclosure: NEMA 250, Type 12, with locking quarter-turn latch and key.

2.2 MONITOR ALARM SEQUENCE

A. Detection Level 1: Notify HVAC control workstation of detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Start ventilation system at low speed to allow occupancy by maintenance technicians to identify leaks.

B. Detection Level 2: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Run ventilation system at high speed on a rise in concentration to this level, and change to low speed on a reduction in concentration below this level. Operate the ventilation system at high speed for a minimum of five minutes.

C. Detection Level 3: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Sound alarm horns inside refrigeration equipment room. Terminate operation of any combustion-process equipment located in the refrigeration equipment room. Provide manual reset for this detection level.

D. Sensor Fault/Trouble: Notify HVAC control workstation of fault/trouble detection in monitor.

2.3 NOTIFICATION APPLIANCES

A. Horns: Comply with UL 464; electric-vibrating-polarized type, listed by a qualified testing agency with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.

B. Visible Alarm Devices: Comply with UL 1971; three color xenon strobe lights, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The words "REFRIGERANT DETECTION" printed in minimum 1/2-inch- high letters on the lens. Rated light output is 110 candela.

2.4 AIR-SAMPLING TUBING

A. Annealed-Temper Copper Tubing: ASTM B 88, Type L.

B. Polyethylene Tubing: ASTM D 2737, flame-retardant, nonmetallic tubing rated for ambient temperature range of 10 to 150 deg F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with ASHRAE 15.

B. Install air-sampling inlets, or diffusion type monitors in pits, tunnels, or trenches in machinery room that are accessible to personnel.

C. Floor mount diffusion-type monitor, sensor/transmitters, or air-sampling inlets on slotted channel frame 12 to 18 inches above the floor in a location near the refrigerant source or between the refrigerant source and the ventilation duct inlet.

D. Wall mount air-sampling multiple-point monitors with top of unit 60 inches above finished floor.

E. Run air-sampling tubing from monitor to air-sampling point, in size as required by monitor manufacturer. Install tubing with maximum unsupported length of 36 inches, for tubing exposed to view. Terminate air-sampling tubing at sampling point with filter recommended by monitor manufacturer.

F. Install air-sampling tubing with sufficient slack and flexible connections to allow for vibration of tubing and movement of equipment.

G. Purge air-sampling tubing with dry, oil-free compressed air before connecting to monitor.

H. Number-code or color-code air-sampling tubing for future identification and service of air-sampling multiple-point monitors.

I. Extend air-sampling tubing from exhaust part of multiple-point monitors to outside.

J. Extend air-sampling tubing from outdoors to outdoor inlet connection of NDIR monitors. Terminate air-sampling tubing at outdoor inlet location with filter recommended by monitor manufacturer.

K. Install warning signs, labels, and nameplates to identify detection devices according to Section 230553 "Identification for HVAC Piping and Equipment."

L. Place warning signs inside and outside each door to the refrigeration equipment room. Sample wording: "AUDIBLE AND VISUAL ALARM SOUNDING INDICATES REFRIGERANT DETECTION - ENTRY REQUIRES SCBA."

M. Audible Alarm-Indicating Devices: Install at each entry door to refrigeration equipment room, and position not less than 6 inches below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

N. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn at each entry door to refrigeration equipment room, and position at least 6 inches below the ceiling.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with requirements.
2. Test and adjust controls and safeties.
3. Test Reports: Prepare a written report to record the following:

a. Test procedures used.
b. Test results that comply with requirements.
c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Repair or replace malfunctioning units and retest as specified above.

3.3 COMMISSIONING

A. Provide commissioning documentation for all inspection, start up, and contractor testing required as recommended by manufacturer.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain refrigerant detection devices and equipment.

END OF SECTION 233500

SECTION 23 3616

TERMINAL BOXES – DDC CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide high velocity terminal boxes, complete with direct digitally controlled velocity controller, electric actuator, velocity pressure pickup device, and attenuator section. Provide reheat coils and fans as scheduled on Drawings and specified herein.

B. Terminal boxes and fan power boxes shall be pressure independent, and suitable for either constant volume or variable volume service as indicated on the Drawings.

C. All terminal box controls, whether factory or field installed, shall be fully compatible with and communicate seamlessly with the building's temperature control or building automation system described in Division 23 Section “Controls and Instrumentation”.

1.2 QUALITY ASSURANCE

A. Standards: American Refrigeration Institute (ARI), National Fire Protection Association (NFPA), and Underwriters' Laboratories (UL).

B. ARI-880: Performance rating.

1.3 RATINGS AND CAPACITIES

A. Refer to the Drawings for CFM, noise criteria and other design requirements.

1.4 MANUFACTURERS

A. Johnson Controls, Titus, Anemostat, Price, and Kreuger.

B. SUBMITTALS

C. Shop Drawings: All equipment items specified.

D. Product Data: Terminal units.

E. Samples: Not required for review.

F. Reference Submittals: Not required for review.

G. Contract Close-Out Information
1. Operating and maintenance data.
2. Owner instruction report.
3. Guarantee.

PART 2 - PRODUCTS

2.1 TERMINAL BOXES

A. General Construction: Galvanized steel, 22 gauge minimum, plenum box with 3/8 inch thick, 1.5 lb. density, fiber-free acoustical thermal lining in accordance with UL 181 and NFPA 90A. Fiberglass lining is not acceptable. Casing leakage shall be less than 13 CFM at 6 inches W.G.

B. Inlet Dampers: Self-seating against a closed cell foam gasket, pivoted on self-lubricating Delrin bearings, mounted directly to the inlet port, and positively connected to a electric operator. Damper leakage not to exceed 8 CFM at 6 inches W.G. in fully closed position.

C. Controls
   1. Each VAV terminal shall include application specific controls with integral microelectronic flow sensors mounted within a NEMA 1 enclosure. The controllers shall have been connected by suitable tubing to a inlet velocity sensor mounted in the inlet to the terminal.
   2. An individual transformer shall be furnished on each VAV terminal to provide power for the controller and the contactors for any required fan and electric heaters at 24 Vac at 50/60 Hz.
   3. Each controller shall control zone temperature by varying the airflow into the space using a PI control loop with programmable proportional and integral coefficients. Applications requiring supplemental heat shall utilize a separate PI algorithm, with programmable proportional and integral coefficients to maintain heating temperature setpoint.
   4. The controllers shall modulate the damper motors to maintain CFM from each terminal in accordance with the cooling/heating requirements calculated by comparing the sensed space temperature with the setpoint and time of day schedule. Zone temperature shall be controlled to +1 degree F. Airflow shall be controlled down to 250 fpm, and shall be read in 25 fpm increments at velocities greater than 500 fpm.
   5. Each controller shall have an internal software clock to implement setpoint changes and changes of control state, in accordance with the resident occupancy. The clocks will be synchronized hourly and automatically following power failures, by a battery backed real-time clock located in the system interface.

D. Damper Operator: Supply suitable bi-directional 24 volt synchronous electric damper actuators. The motors shall have heavy duty gears and shall contain a magnetic clutch which releases when the damper is driven to either extreme. Stall type actuators or DC actuators without current limiting are not acceptable. The operator shall be sized to accurately and smoothly operate the damper through the expected CFM range of the terminal, against a duct static pressure ranging up to the largest external static pressure scheduled on the Drawings.

E. Sound Attenuator Section: 22 gauge, galvanized steel with insulation lining to match the terminal box lining, 3 foot length minimum (unless noted otherwise on Drawings).

F. Velocity Pickup: Ring or cross-shaped, multi-point center averaging type velocity pressure pickup shall be provided by Box Manufacturer. Velocity pickup shall amplify the duct velocity pressure, and maintain control accuracy with inlet ducts in any configuration. Single point or a single inline multiple point velocity pickups will not be accepted.

G. Hot Water Coil
   1. Galvanized steel casing, flanged duct connection at unit discharge, 1/2 inch diameter copper tubes, aluminum fins, solder connections, one or two row serpentine coil (refer to scheduled data on Drawings for performance requirements and required number of rows). All coils shall be factory installed.
   2. Insulate the entire exposed perimeter of hot water coil.
   3. Provide hot water control valve and operator, compatible with terminal box controls.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support boxes independent of ceiling system. Coordinate with General Trades Contractor.

B. Provide access as required for maintenance and repair. All boxes located above the ceiling shall be end discharge unless otherwise noted. All boxes shall deliver the air quantities shown on the Drawings at acceptable sound levels.

C. Make flexible duct and flexible connections at box duct connections. Provide a transition from the full size of each terminal outlet to the discharge ductwork shown on Drawings. Transition shall be tapered with a 60 degree maximum included angle.

D. Coordinate installation of controls.

E. Install hot water piping, valves and specialties.

END OF SECTION 23 3616

SECTION 23 3714

INDOOR AIR HANDLING UNITS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The following manufacturers are approved for use:
   1. Daikin
   2. York
   3. Temtrol
   4. Carrier

1.1 UNIT CONSTRUCTION

1. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
2. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
   a. The inner liner shall be constructed of G90 galvanized steel.
   b. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16” at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
   c. The floor plate shall be constructed as specified for the inner liner.
   d. Unit will be furnished with solid inner liners.
3. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
4. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5” w.c. in positive pressure sections and -6” w.c. in negative pressure sections (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure)

5. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
6. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
7. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping.. The base rail shall be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. The following calculation shall determine the required height of the baserail to allow for adequate drainage. Use the largest pressure to determine base rail height. [(Negative)(Positive) static pressure (in)] (2) + 4” = required baserail height. Should the unit baserail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.
8. A round window inspection port shall be provided on unit section(s) as indicated on unit schedule and drawings.
9. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3’’ above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2’’ thickness of insulation under drain pan.

1.2 FAN ASSEMBLIES

1. Provide ECM, motorized impeller fan(s). Fan assembly shall include fan, fan base, and a motor and shall be dynamically balanced by the fan manufacturer.
    a. Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault.
    b. Motor control panel shall come equipped with a fused disconnect.
    c. Fan section shall come equipped with a motor control panel mounted on the fan section. Both line voltage and low voltage wiring shall be done by the factory. Each fan shall have an isolation switch.
    d. Motor shall be brushless DC type with a permanent magnet rotor.
    e. Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.
    f. Each direct drive fan in a multiple-fan array shall be provided with integral back flow prevention: a backdraft damper that prohibits recirculation of air in the event a fan or multiple fans become disabled. Dampers are tested and rated based on AMCA Standard 500. Dampers to be heavy duty type capable of a maximum back pressure that exceeds the design total static pressure with minimal leakage. The dampers should have a minimal total effect on airflow performance; both pressure drop when open and system effect on the fan. The damper blades and frame shall be extruded aluminum with blade edge seals locked into the blade edge. Adhesive type seals are unacceptable. AHU manufacturer responsible for providing proper spacing upstream of dampers to ensure full, uniform airflow through upstream components.

1.3 BEARINGS, SHAFTS, AND DRIVES

1. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

1.4 ELECTRICAL

1. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
2. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
3. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
4. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.
5. Provide marine light, in each section as shown on project schedule, mounted and wired to a junction box with an on-off switch and GFI receptacle mounted on the outside of the cabinet.

1.5 COOLING AND HEATING COILS

1. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
2. Water cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
    a. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
    b. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
    c. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
    d. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections

provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.

e. Coil casing shall be a formed channel frame of galvanized steel.

3. Horizontal tube integral face and bypass hot water coil shall be furnished and consist of multiple alternating heating sections and bypass sections, with airflow distributed to each by interlocking wrap-a-round "clamshell" style dampers; linkage to be stainless steel. Coils shall be suitable for continuous operation at 200 psig and 400 F degrees. Heating elements to consist of multi-row, multi-pass extended heat transfer surface; coil shall carry ARI 410 certification as to ratings. Welding and brazing shall be done by ASME qualified personnel.
   a. Headers shall be single piece carbon steel, with no separate disks or caps welded or brazed into header ends. Connections shall be steel and shall be welded to header barrels.
   b. Fins shall be continuous patterned plate, .0075" thick aluminum with full fin collars.
   c. Tubes shall be 5/8" diameter seamless copper, .035" average wall thickness. Joints shall be silver brazed.
   d. Casings and dampers shall be minimum 16 gauge mill galvanized steel; top and bottom casing panels to be double flanged for stacking. End casings shall have smooth, embossed tube holes to provide adequate bearing surface for tubes to avoid abrasion during expansion and contraction. Flexible connectors shall not be required.

1.6 FILTERS

1. Furnish flat panel filter section with 2-inch pleated MERV 8 filter. Provide side loading and removal of filters.
2. Furnish flat panel filter section with 4-inch filter. Provide side loading and removal of filters.
3. Filter media shall be UL 900 listed, Class I or Class II.
4. Filter Magnehelic gauge(s) shall be furnished and mounted by equipment manufacturer.

1.7 ADDITIONAL SECTIONS

1. Plenum section shall be provided and properly sized for inlet and/or discharge air flow (between 600 and 1500 feet per minute). The plenum shall provide single or multiple openings as shown on drawings and project schedule.
2. Access section shall be provided for access between components.
3. Blender / air mixer section to provide proper air mixing and distribution of the outside and return airstreams. Provide proper spacing provided in the direction of airflow as recommended by the blender manufacturer - Kees, inc.
4. Economizer section shall be provided with top outside air opening and end return air opening and top exhaust air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow. Return and outside air dampers of different sizes or very large dampers and exhaust dampers must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with manufacturer's latest issued instructions and all applicable inspection and code authority requirements.
B. Verify applicable voltage, phase, and protective device requirements with electrical contractor before manufacture or installation of equipment.

END OF SECTION 233714

SECTION 235216

CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this

B. This section includes condensing hot water boiler(s) for indoor space-heating application.

1.2 REFERENCES

A. Intertek (ETL)

1. ETL certified to UL 795/CGA 3.1

B. American Society of Mechanical Engineers:

1. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers

2. ASME CSD-1 – Controls and Safety Devices for Automatically Fired Boilers]

C. American Society of Heating, Refrigeration and Air Conditioning Engineers

1. ASHRAE: Standard 90.1 Energy Standard for Buildings

D. Hydronics Institute, Division of Air Conditioning, Heating & Refrigeration Institute (AHRI):

1. AHRI1500: Testing Standard to Determine Efficiency of Commercial Space Heating Boilers as defined by Department of Energy in 10 CFR Part 431.

E. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code (ANSI Z223.1)

1.3 SUBMITTALS

A. In accordance with Contract Documents. Minimum product data to include:

8. Capacities, accessories and options included with boiler.
9. General layout, dimensions, size and location of all required connections.
10. Electrical characteristics
11. Weight and mounting loads.
12. Manufacturer's installation and start-up instructions.
13. Equipment Operation and Maintenance Manuals.

1.4 QUALITY ASSURANCE

A. Use an adequate number of skilled workers, trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements, pertinent contract documents, and methods needed for proper performance of the work described therein.

B. Provide the services of a manufacturer's factory-authorized representative to inspect and verify proper installation of this equipment, and to provide equipment start-up and operator training.

1.5 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Contract Documents.

B. Accept equipment and accessories in Factory shipping packaging. Inspect for damage. Keep boiler in a horizontal position from time of delivery to final installation.

C. While stored, all equipment must be protected from external elements such as inclement weather, job site construction activity, etc. Protect equipment from damage by leaving packaging in place until installation.

1.6 WARRANTY

A. The boiler shall come with the warranties stated below from date of original installation.

8. Heat Exchanger: 10-year pro-rated warranty.

9. All other parts: 1-year limited warranty.

10. At owners option the manufacturer shall make available a factory authorized additional 5-year parts and labor warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Thermal Solutions Amp Boiler, Bryan Boilers BFit Boiler or approved equal.

B. It shall be the responsibility of the Contractor to insure that any substituted equipment is equivalent in fit, form and function to the specified equipment. The cost of any additional work caused by the substitution of equipment shall be borne by the Contractor.

C. Refer to the Equipment Schedule in the Contract Drawings for the specific design and performance criteria.

2.2 GENERAL REQUIREMENTS

A. Boiler

1. The boiler shall be assembled, firetested and shipped as a factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted & wired, with boiler connections specified in this Section.

2. The boiler shall be constructed in conformance to ASME Section IV, ASME CSD-1 and UL 795. The boiler shall bear the ASME “H” stamp with a maximum allowable working pressure (MAWP) of 160 PSI. Pressure vessel shall be subjected to a hydrostatic pressure test of 240 PSIG at the factory.

3. The boiler shall be an ultra-high efficiency condensing boiler with a pressure vessel, constructed of 316L stainless steel and of water tube design, which shall not require a refractory combustion chamber. Pressure vessel shall have a minimum heat transfer area of 91.6 square feet and a waterside pressure loss no more than 5.2 feet of head at a 30°F difference between the supply and return water

temperatures. Pressure vessel shall be capable of handling water flow rates between 35 gpm and 450 gpm.

4. The boiler shall be equipped with an integral pre-mix, stainless steel forced draft burner incorporating full modulation with 5:1 turndown. The burner shall be of high flame retention design and have a static swirl device to get uniform flame stability all around the combustion surface. Burner shall be equipped with a sliding guide rail with hinged door to gain full access and inspection of the burner and combustion chamber.

5. The boiler gas valve will be designed with zero pressure regulation and equipped with a variable speed blower system to precisely control the fuel/air mixture, providing fully modulating firing rates for maximum efficiency.

6. Water connections shall be located at the top of the boiler; flue gas exhaust, combustion air intake and condensate drain connections shall be located in the rear of the boiler and incoming gas connection shall be located on the left side of the boiler. A factory supplied oversized ASME relief valve shall be provided with the boiler(s).

7. The flue passages and combustion chamber shall be accessible from the front of the boiler for cleaning.

8. The boiler shall be provided with a heavy duty 16 gauge steel jacket with a rust resistant powder coat finish. Jackets made of plastic or resin material shall not be acceptable. The boiler jacket shall contain an internal electrical cabinet for power and limit circuit wiring, providing a clean finished look when the jacket is installed. Electrical connections shall be accessible from top and/or left-side of the boiler on five (5) printed circuited boards (120VAC high and 24VAC/5VDC low voltage) with fused connections for protection and clear labeling for simple and accurate wiring.

    a. The electrical components shall be separated from incoming combustion air gas, which may contain excess humidity, dust and other contaminants brought through ducted combustion air.

9. A polypropylene condensate trap with a float-actuated shut-off switch shall be supplied with the boiler.

10. Electrical input to the boiler shall be 208v/1ph/60hz.

11. The boiler shall be of compact design with no more than 33.3 cubic/ft and a footprint no larger and 10.9 sq/ft.

12. Boiler shall be capable of variable primary or primary/secondary piping arrangements.

13. The boiler shall come on a base with forklift opening all sides and lifting lugs for ease of moving and rigging.

B. Boiler Control System

1. Scope of Supply

Boiler Control System shall provide safety interlocks and water temperature control. The control system shall be fully integrated into the boiler control cabinet and incorporate single and multiple boiler control logic, inputs, outputs and communication interfaces. The control system shall coordinate the operation of up to eight (8) fully modulating hot water boilers and circulation pumps. The control system shall simply control boiler modulation and on/off outputs based on the boiler water supply temperature and an operator-adjusted setpoint. However, using parameter menu selections, the control system shall allow the boiler to respond to remote system water temperature and outside air temperatures, remote setpoint or remote start/stop commands.

2. Boiler Control

Using PID (proportional-integral-derivative) based control, the remote system water temperature shall be compared with a setpoint to establish a target boiler firing rate. If the secondary loop flow speed is greater than the primary loop flow speed, firing rate is increased in response to the decrease in secondary loop temperature. When the remote system temperature is near the boiler high limit temperature, the boiler supply sensor shall limit the maximum boiler supply temperature to prevent boiler high limit events. Alternately, using parameter menu selections, the control system shall allow the boiler to respond directly to boiler supply temperature and setpoint to establish a target boiler firing rate while remote system water temperature is used for display purposes only. Each boiler's fuel flow control valve shall be mechanically linked to the air flow control device to assure an air rich fuel/air ratio. All the automated logic required to ensure that pre-purge, post-purge, light-off, and burner modulation shall be provided.

3. Hot Water Temperature Setpoint

When the controller is in the local control mode, the control system shall establish the setpoint based on outside air temperature and a reset function curve, or be manually adjusted by the operator. When enabled, the setpoint shall be adjusted above a preset minimum setpoint upon sensing a domestic hot water demand contact input. When in remote mode, the control system shall accept a 4-20ma or 0-10 Vdc remote setpoint or firing rate demand signal from an external BAS.

4. Multiple Boiler Sequence

The controller shall incorporate its peer-to-peer communications on each connected boiler (up to eight [8] units) by using standard RJ45 ethernet cables. The control system shall allow the connected boilers to exchange signals as required to provide coordinated fully modulating lead/lag functions. It shall not be required to wire individual control signals between boilers. Multiple boilers shall be modulated in "Unison" (all at the same firing rate). To increase operational efficiency, the control system shall utilize both water temperature and firing rate based boiler sequencing algorithms to start and stop the boilers and shall minimize the total number of boilers in operation. The control system shall start and stop boilers when the water temperature is outside the adjustable temperature limit for longer than the adjustable time delay. In order to minimize temperature deviations, the control system shall start and stop the next boiler when the "lead" boiler is at an adjustable firing rate limit for longer than the

adjustable time delay. The control system shall monitor both boiler lockout and limit circuits to automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. The boiler shall be run at low fire for warm-up for a preset low fire hold time. When enabled, warm weather shut down control logic shall prevent boiler operation. The controller shall also be capable of auto-rotation of the boilers based on user-selected run time hours.

5. User Interface
A touch screen message display shall be provided to display real time BTU/hr, numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and boiler historical information. In the event of a fault condition, the display shall provide help screens to determine the cause of the problem and corrective actions. Historical information shall include graphical trends, lockout history, boiler & circulator cycle counts and run time hours.

6. Circulator Control
The controller shall be capable of sequencg the boiler, domestic hot water or system circulators. Simple parameter selections shall allow all three pumps to respond properly to various hydronic piping arrangements including either a boiler or primary piped indirect water heater. The controller shall perform circulator exercise to help prevent pump rotor seizing.

7. EMS Communication
Control and monitor the boiler via communication RS485 Modbus or direct wiring. The control shall allow for simultaneous communication for boiler peer-to-peer communication and EMS communication interfaces. Loss of EMS communication shall automatically transfer the boiler control to local operation. Boiler operation shall not be lost due to corrupt or loss of EMS communication. The boiler control system shall allow individual boiler limits, lockout, boiler and system temperatures and firing rate status to be readable and water setpoint, boiler firing rate, and start/stop command to be readable and writable. The control shall provide easy parameter selection and options for the following: Modulation Source (4-20ma or 0-10 Vdc); Setpoint Source (4-20ma or 0-10 Vdc); and Enable/Disable (contact wired or Modbus). The control shall allow a real time, live & convenient list of all interface signals to allow for quick interface verification. The boiler control system shall network with a communication gateway to connect with BACnet communication protocol.

8. External Data Transfer
The control system shall include the ability to transfer parameters from boiler to boiler. Upon completion of commissioning the first boiler, a USB flash drive shall allow settings to be “downloaded” from one boiler and “uploaded” into the next. Additionally, these files shall be able to be sent via email and “uploaded” to a remote technical support system. Additionally, it shall be possible to restore parameters to the “as shipped state” by selecting a “Factory Default” Button.

9. Archive History
All hard lockouts, soft lockouts (holds), sensor faults, Energy Management System (EMS) signal faults, sequencer faults and limit string faults shall be recorded with a time and date stamp. The time and date log shall stores up to

3000 alarm & events even after power cycle." The alarm & event log must be downloadable to a USB thumb drive. The control shall include collect and store supply & return temperature, flame intensity and firing rate for at least 4 months. It shall be a simple matter to page through the boiler's operation using the boiler mounted display or download the historical data to a USB thumb drive for off-site analysis. All data must be stored in standardly compatible CRV files.

10. Quality Assurance
The boiler control system shall be supplied as part of a factory-assembled and tested burner control cabinet.

B. Boiler Trim

1. Combination pressure-temperature gauge, 3-1/2 inch diameter.
2. Supply and return temperature sensors - shall be mounted on the supply and return connections outside of the boiler jacket. Each sensor shall be accessible from the top of the boiler. The boiler control shall measure supply and return temperatures and notify the operator if the direction of flow is reversed.
    a. The boiler control shall adjust to impending temperature changes in such a way to minimize fuel consumption and maximize efficiency. The control shall measure temperatures and the rate of change in those temperatures and respond early, rather than waiting for temperatures to exceed limit control settings.
3. Flue gas temperature sensor shall be mounted in the flue vent connector to monitor flue gas temperatures and reduce the blower speed when flue gas temperatures exceed 189°F. If the flue temperatures exceed 195°F, a forced boiler recycle results.
4. ASME Section IV safety relief valve sized to exceed the gross output of the boiler which shall be factory set to relieve pressure at [30, 50, 60, 75, 100 or 125 psig] water working pressure.
5. Water flow switch to prevent the burner operation during low water flow conditions.
6. High Temperature Limit, automatic and manual reset, to prevent burner operation if water temperature conditions rise above maximum boiler design temperature, wired to put the boiler into a hard lockout, requiring manual reset of the boiler primary control.
7. High and low gas pressure switches with manual reset and a range of 4 - 14 in W.C., wired to put the boiler into a hard lockout, requiring manual reset of the boiler primary control.
8. Low water cutoff (LWCO) device with manual reset. Boiler shall be fitted with a probe type LWCO located above the lowest safe permissible water level established by the boiler manufacturer. LWCO shall be UL listed and suitable for commercial hydronic heating service.

E. Vent & Intake Air Connections

1. The exhaust vent must be UL 1738 listed for use with Category II and IV appliances and compatible with operating temperatures up to 210°F, positive pressure, condensing flue gas service. UL certified vent material shall be AL29-4C or equal.
2. The exhaust vent system shall be in accordance with National Fuel Code, NFPA 54/ANSI Z221.3, or applicable provisions of local building codes.
3. Combustion air intake shall be capable of drawing air from inside the room or ducted from outdoors. Ducted piping shall be PVC or galvanized smoke pipe that is sealed and pressure tight. Pipe must be at least the same size as the inlet air connection on the boiler.
4. Combustion air intake shall be connected into the boiler vestibule NOT directly into the boiler blower assembly. Combustion air shall be preheated by passing around the exterior of the boiler furnace section before entering the pre-mix gas/air assembly.
5. Boiler shall be capable of common venting with an engineered vent system.
6. Venting shall have an equivalent length of up to 200 feet maximum when drawing air from inside the room or Venting shall have an equivalent length of up to 100 feet maximum and ducted combustion intake air shall have an equivalent length of up to 100 feet maximum.

2.3 PERFORMANCE

A. Boiler thermal efficiency shall be certified with no less than 97.0%.

B. The burner shall emit low NOx (corrected to 3% O_2) emissions at all firing rates.

C. Provide services of a manufacturer's authorized representative to perform combustion test including boiler firing rate, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, mid-range, and high fire.

PART 3 EXECUTION

3.1 INSTALLATION

A. In accordance with Contract Documents and boiler manufacturer's printed instructions.

B. Flush and clean the boiler upon completion of installation in accordance with manufacturer's start-up instructions. The boiler must be isolated when any cleaning or testing of system piping is being performed.

C. Install skid plumb and level, to plus or minus 1/16 inch over base.

D. Maintain manufacturer's recommended clearances around and over equipment, and as required by local Code.

E. Arrange all electrical conduit, piping, exhaust vent, and air intake with clearances for burner removal and service of all equipment.

F. Connect exhaust vent to boiler vent connection.

G. If shown in Contract Drawings, connect full sized air inlet vent to flanged connector on boiler.

H. Connect fuel piping in accordance with NFPA 54. Pipe size to be the same, or greater, than

the gas train inlet connection.

I. Use full size (minimum) pipe/tubing on all gas vent connections.

J. Connect water piping, full size, to supply and return connections.

K. Install all piping accessories per the details on the contract drawings.

L. Install discharge piping from relief valves (open termination for viewing) and all drains to nearest floor drain.

M. Provide necessary water treatment to satisfy manufacturer's specified water quality limits.

END OF SECTION 235216

SECTION 23 6427

AIR-COOLED CHILLERS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including, but not limited to, Division 01, General Requirements.

B. See Division *23 Section "Vibration Controls for HVAC Piping and Equipment"*, for vibration analysis acceptance testing.

PART 2 - PRODUCTS

2.1 Operating Conditions

A. Provide air-cooled split-system liquid chiller with the capacity as scheduled on drawings.

B. Chiller shall be designed to operate using R-410 Refrigerant.

C. Chiller shall be designed for parallel evaporator water flow.

D. The liquid to be chilled will be water containing corrosion inhibitors.

E. Chiller shall be designed to operate using 480 volt, 3 phase, 60 (50) Hz electrical power supply.

2.2 Air-Cooled Split-System Chiller

A. Approved manufacturer is MULTISTACK.

B. System Description: Chiller shall incorporate Scroll type compressors and can consist of multiple modules. Each refrigerant circuit shall consist of an individual compressor, common dual circuited evaporator, thermal expansion valves, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit chiller must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits. Circuits shall be charged with 80 lbs of static nitrogen.

C. General

1. Chiller Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236.

2. Modules shall ship wired and charged with nitrogen.

3. Compressors, heat exchangers, piping and controls shall be mounted on a heavy gauge, powder coated steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module.

D. Each module shall be supplied with a light weight aluminum frame with sound reduction panels. Panels are powder coated 20 gauge steel with 1" of fiberglass insulation to reduce sound levels. Optional sound package will reduce sound pressure levels measured at 1 meter at a minimum of 12 dBA.

E. Chilled Water Mains: Each module shall include supply and return mains for chilled water. Cut grooved end connections are provided for interconnection to six inch standard piping with grooved type couplings. Rolled grooved shall be unacceptable. Water Mains shall be installed such that they are beneath any power or control wiring so as to insure for safe operation in the event of condensation or minor piping leaks.

F. Evaporators: Each evaporator shall be a brazed plate heat exchanger constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig refrigerant side working pressure and 362 psig water side working pressure. The evaporator heat exchanger shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

G. Compressor: Each module shall contain two hermetic compressors independently circuited and with internal spring isolation mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure manual reset safety cut-outs.

H. Central Control System

1. Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.

2. The Master Controller shall monitor and report the following on each refrigeration system:

   a. Discharge Pressure Fault
   b. Suction Pressure Fault
   c. Compressor Winding Temperature
   d. Suction Temperature
   e. Evaporator Leaving Chilled Water Temp.

3. The Master Controller shall monitor and report the following system parameters:

a. Chilled Water Entering and Leaving Temperature
b. Chilled Water Flow

4. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).

5. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.

6. The control system shall monitor entering and leaving chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to optimize the chiller performance to different existing building loads.

7. The Chiller shall be capable of interfacing to a building automation system. Interface shall be accomplished using an Interoperability Web Portal and shall be capable of communication over BACNet, Modbus or LON.

8. Chiller shall have a single point power connection and external inputs and outputs to be compatible with the building management system.

Inputs/Outputs include:

1. Remote Start/Stop
2. Cooling Alarm
3. Provide 0-10 volt DC or 4-20 mA input for customer reset of chiller setpoints.

J. Each inlet header shall incorporate a built in 30-mesh (max) in-line strainer system to prevent heat exchanger fouling.

K. Each refrigerant circuit shall include all refrigerant specialties factory mounted to provide reliable operation down to 45°F Ambient. These refrigerant specialties shall include all required components including:

1. Thermal Expansion Valve

2. Liquid Line Filter/Drier
3. Liquid Line Solenoid Valve
4. 50 lb Liquid Receivers with Isolation Valves
5. Check Valves to prevent refrigerant migration to outdoor condenser

L. Matching Remote Air Cooled Condenser

1. Provide matching remote air cooled condensers matching dimensions and clearances as shown on plans.
2. Provide independent refrigerant circuiting with dedicated fans. Condensers with fans which overlap multiple refrigerant circuits will not be accepted.
3. Provide pressure fan cycling controls for all condenser fans.
4. Provide head pressure control valves for flooded condenser operation for low ambient operation. These valves will be supplied by chiller manufacturer and field installed.

M. IFM flow switch per module. Integral to each module and powered by the module for individual module proof of flow and flow safety. Modules without independent IFM switches per module are not acceptable alternates.

N. Single Point Power: Chiller shall be equipped with a pre-engineered genuine buss bar electrical system for single point power at a 5,000 amp SCCR. Where the equipment size exceeds the amp rating of the buss bar, multiple power connections may be applied. Pre-engineered system shall also incorporate individual module isolation circuit breakers for full redundancy and ability of a module to be taken off-line for repair while the rest of the modules continue to operate. Individual power feeds to each module shall be unacceptable.

2.3 SAFETIES, CONTROLS AND OPERATION

A. Chiller safety controls system shall be provided with the unit (minimum) as follows:

1. Low evaporator refrigerant pressure
2. Loss of water flow through the evaporator
3. High condenser refrigerant pressure
4. High compressor motor temperature
5. Low suction gas temperature
6. Low leaving evaporator water temperature

B. Failure of chiller to start or chiller shutdown due to any of the above safety cutouts shall be annunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.

C. The chiller shall be furnished with a Master Controller as an

integral portion of the chiller control circuitry to provide the following functions:

1. Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.

2. Provisions for connection to automatically enable the chiller from a remote energy management system.

3. The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.

4. Each module shall contain a slave controller that will allow any module to run in the event of a master controller failure or loss of communication with the master controller via an on/off/manual toggle switch.

D. Normal Chiller Operation

1. When chiller is enabled, the factory supplied Master Controller modulates the chiller capacity from minimum to maximum as required by building load.

2. The Chiller control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

E. Power Phase Monitor

1. Provide a Power Phase Monitor on the incoming power supply to the chiller. This device shall prevent the chiller from operating during periods when the incoming power is unsuitable for proper operation.

2. The Power Phase Monitor shall provide protection against the following conditions:

   a. Low Voltage (Brown-Out)
   b. Phase Rotation
   c. Loss of Phase
   d. Phase Imbalance

E. Variable Flow Operation - Chilled Water

1. Butterfly type isolation valves shall incorporate appropriate accessories and controls to allow the chiller to operate efficiently in a variable primary flow system. Valve shall modulate via a motorized actuator for return water temperature control, chiller minimum flow bypass, chiller no load bypass.

PART 3 INSTALLATION

3.1 PIPING SYSTEM FLUSHING PROCEDURE

A. Prior to connecting the chiller to the chilled water loop, the piping loop shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organic residue. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.

B. During the flushing, a 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The use of on board chiller strainers shall not be acceptable. Use of the on board chiller strainers shall not be acceptable. The flushing process shall take no less than 6 hours or until the strainers when examined after each flushing, are clean. Old systems with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer's instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

C. Prior to supplying water to the chiller the Water Treatment Specification shall be consulted for requirements regarding the water quality during chiller operation. The appropriate chiller manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

3.2 Water Treatment Requirements

A. Supply water for both the chilled water circuit shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified for the chiller's heat exchanger, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for modular chillers using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within the following parameters:

1. pH	Greater than 7 and less than 9
2. Total Dissolved Solids (TDS)	Less than 1000 ppm
3. Hardness as $CaCO_3$	30 to 500 ppm
4. Alkalinity as Ca CO_3	30 to 500 ppm
5. Chlorides	Less than 200 ppm
6. Sulfates	Less than 200 ppm

3.3 Warranty and Start-Up

A. Manufacturer's Warranty: Manufacturer shall provide full parts-only warranty coverage for entire chiller for a period of one year. All parts shall be warranted against defects in material and workmanship. Similar parts-only coverage shall be provided for the chillers compressors for a period of five years. The warranty period shall commence either on the equipment start-up date or six months after shipment, whichever is earlier.

B. Manufacturer shall provide the services of a Factory Authorized Service Engineer to provide complete start-up supervision. Factory Authorized Service Engineer shall also be responsible for assembly of the chillers cabinetry package and electrical bus bar system. After start-up a Manufacturer's Representative shall provide a minimum of 8-hours of operator training to the owner's designated representative(s).

END OF SECTION 23 6427

DIVISION 25

CONTROLS

SECTION 25 00 00

INTEGRATED AUTOMATION AND HVAC CONTROL

PART 1 - GENERAL

1.01 BUILDING AUTOMATION SYSTEM (BAS) DESCRIPTION

A. This Building Automation System (BAS) Contractor shall supply and install a complete Building Automation System (BAS) as required to accomplish the specified sequences of operation for control of heating, ventilating, air-conditioning and other building equipment and systems as described herein. All work in this Section shall be coordinated and provided by a single BAS Contractor. This system in its entirety shall comply with all the networking requirements of a BACnet® system as defined by the latest ASHRAE Standard135-2016. This includes but is not limited to the following:

1. A Web-based GUI for day-to-day operations hosted on an Enterprise-Level BACnet® Operator's Workstation (B-OWS) as described below.

2. BACnet® Advanced Operator Workstation (B-AWS) as described below and listed in the plans and specifications. This workstation shall include all the necessary software to setup, configure and program all BAS system DDC controllers. This shall include any software whose function is to set network and configuration settings, program logic and create graphics including custom graphic libraries used in the creation of this project's graphics.

3. Direct digital Controllers suitable to the applications and sequences as described herein.

4. All final control elements, (damper actuators, valve actuators, relays etc.) as required to meet the sequence of operations and suitable to the applications as specified.

5. Control valves as listed for BAS controlled equipment.

6. Integration to the following third-party systems to BACnet:

    a. Controls supplied as integral to packaged equipment.

    b. Integral electric distribution metering.

    c. Integration to the above systems shall include making available to the BACnet internetwork all discoverable BACnet objects.

7. Installation and wiring of all ancillary control devices supplied by packaged equipment manufactures as loose components to be field installed.

8. Line voltage controls as listed and specified.

9. Low voltage non-DDC controls as listed and specified.

10. For attic stock the recommended spare parts as delineated in the submittals and record documents.

11. All licensing necessary to provide routine updates and bug fixes to all software and firmware for a period of five (5) years.

12. A five (5) year warranty in writing on all DDC equipment installed as part of this contract. This includes all ancillary devices (sensors, actuators, output devices etc.) installed as part of this contract. It is acceptable to offer extended warranties through the BAS contractor to meet the intent of this criteria.

13. Detail routine maintenance requirements for all system components.

B. The Building Automation System (BAS) Contractor shall conform with the following requirements to meet the requirements of the specification:

1. Must be an established controls contractor regularly employed in the installation of Building Automation Systems.

2. Include sufficient labor to attend weekly coordination meetings during installation and project acceptance periods.

3. Must have at least ten (10) support personnel within a forty (40) mile radius of the City of Columbus.

4. Provide a minimum of twenty (20) hours or as detailed in PART3 – Execution of this specification for assistance to the Master Systems Integrator to ensure successful integration of site into the Enterprise-Wide Building Automation Network.

5. Provide training to Owner's designees including the Master Systems Integrator as detailed in PART3 – Execution of this specification or a minimum of sixteen (16) hours.

6. Provide Owner and Owner's designees, including Master Systems Integrator, with unlimited phone, email and technical programming support through the warranty period.

7. Provide minimum of four (4) hour emergency on-site response time.

C. In order to begin the acceptance process detailed in PART3 – EXECUTION the system must operate alarm free for one hundred and twenty (120) hours. This time period begins over for any alarm unless the contractor initiates a review process with the Owner's designee, the Commissioning Agent, and the design team. This team may determine that the alarm(s) was a result of circumstances beyond the control of the Building Automation System (BAS) Contractor.

D. The Building Automation System (BAS) shall consist of a high-speed, peer-to-peer internetwork of ANSI/ASHRAE 135 native BACnet® DDC devices. The control system shall also incorporate input/output devices, mechanical/electrical automatic temperature control devices, enclosures, interconnecting conduit and cabling.

E. The BACnet® operating stack must be embedded directly in each individual DDC device at the media access controller level and in all operator interface and configuration applications.

1. Communication gateways, bridges, protocol translators or any other device that translates any proprietary communication protocol to BACnet® shall not be permitted as a part of the Building Automation System (BAS) provided pursuant with this specification except as required to communicate to existing building systems or existing packaged equipment integral controls.

F. All DDC devices shall be tested, certified, clearly stamped and listed by the BACnet® Testing Laboratories (BTL) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

G. The Building Automation System (BAS) shall be modular in nature and implemented in such a manner that it can be expanded in both capacity and functionality through the addition of DDC controllers, devices and wiring.

H. All logic required to perform the specified sequences of operation, trending and alarming as outlined in this specification shall reside in each individual DDC device. Should network communications fail, each device shall be capable of performing local control strategies without reliance upon any other device.

1. DDC devices that require any supervisory server software or hardware or any external platform to manage database execution or network management shall not be permitted as a part of the Building Automation System (BAS) provided pursuant with this specification.

I. The Building Automation System (BAS) contractor shall supply at least one operator's workstation with all the necessary software and a full set of administrative credentials for all software associated with the project at the project outset.

J. The Building Automation System (BAS) Contractor shall conform with the following requirements to meet the requirements of the specification:

K. The Building Automation System (BAS) Contractor shall include a separate line item bid a written proposal for a five (5) year maintenance agreement. This agreement shall be listed as a separate line item on any quote. This agreement shall include at a minimum the following:

1. Remote Monitoring Services

a. Using a remote connection, the Building Automation System (BAS) Contractor shall centrally monitor the BAS to ensure adherence to the published sequence of operations/specifications, and report issues to maintenance staff as needed.

2. On-going Commissioning

a. This includes:

1) System/component level point monitoring, performance verification, and operational improvement reporting/prioritization.

2) Up to 120 hours of BAS re-programming, replacing (out of attic stock)/recalibrating sensors, conducting functional tests, training maintenance staff. Provide guaranteed component pricing for all attic stock for the duration of the service agreement term.

3. BAS Maintenance

a. Perform system backups, inspecting control panels, cleaning system components (e.g. air sampling devices, sensors, dampers, actuators, valves, panels), analyzing system performance, reconciling system alarm/trend data, and replacing fuses/pneumatic filters from in-house stock.

4. Owners Representation and Engineering Services

a. Up to 20 hours performing measurement & verification services, developing energy efficiency awareness programs, evaluating energy supply agreements, applying for energy related grants, and advocating on behalf of client with key stakeholder groups.

1.02 BID REQUIREMENTS

A. The following items are to be included in the bid submittal in order to allow the owner to properly vet bidding contractors:

1. Base contract price excluding the following items

2. Service agreement pricing as detailed above.

3. Enterprise Level Server and software pricing

4. Attic stock guaranteed markup (for five (5) years)

B. In addition to pricing requirements the following items are also to be included with bid proposals:

1. Statement of Compliance. It is understood that this is a stringent specification and that all manufacturers may not be able to meet all the criteria. This document is to allow the contractor to list whether they are in compliance with all aspects of this document and to list those which they cannot fully meet. This then allows the owner to evaluate the importance of particular aspects of this specification to their long term operation of the facility.

2. Warranty statement indicating the length of the warranty period.

1.03 BUILDING AUTOMATION SYSTEM (BAS) ARCHITECTURE

A. BACnet®. The Building Automation System (BAS) as provided and installed under this specification shall comprise a BACnet® Internetwork. All communication shall conform to ANSI/ASHRAE Standard 135, BACnet®.

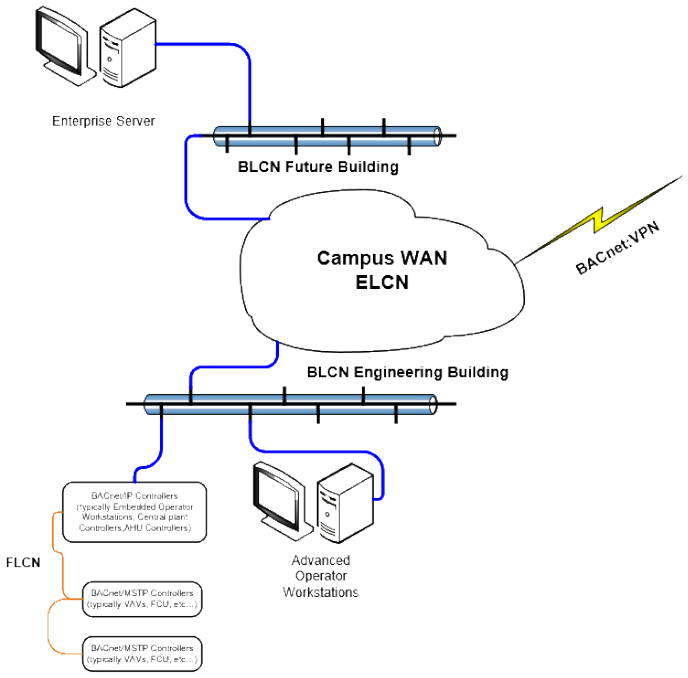
B. Consistency. The Building Automation System (BAS) as provided and installed under this specification shall be a complete system from a single manufacturer designed for use on intranets and the Internet.

C. FLCN. Field Level Communication Networks (FLCNs) shall be comprised of BACnet® networks of unitary BACnet® controllers and devices using the BACnet® data link Master Slave/Token Passing (MS/TP).

D. BLCN. Building Level Communication Networks (BLCNs) shall be comprised of a BACnet®/IP Local Area Network (LAN) for the interconnection of FLCNs, BACnet® devices and operator interfaces using the BACnet® data links BACnet®/IP (B/IP) or BACnet®/Ethernet (ISO 8802.3).

E. ELCN. An Enterprise Level Communication Network (ELCN) shall be comprised of a BACnet®/IP Wide Area Network (WAN) for the interconnection of BLCNs and high level operator interface (HLI) using the BACnet® data link BACnet®/IP (B/IP).

F. The diagram below is a simplified network architecture.



G. Internetwork. Internetwork operator interface and BACnet® communication shall be transparent to network architecture.

1. BACnet® communication shall be automatically routed to all configured BACnet® networks by DDC control devices on the internetwork. Dedicated, stand-alone BACnet® routers and/or routing devices shall be subject to approval prior to deployment. In all cases where a DDC controllers has integral routing capabilities this shall be the preferred method of BACnet® routing

1.04 RELATED WORK

A. Conformance with all sections of the specification is required. Additional requirements for the equipment specified within this section are included in, but not limited to, the following sections:

1. 20 05 00, "General Mechanical Requirements”

1.05 REFERENCE

A. General Requirements of Division 1 govern work under this section.

B. Electrical Requirements Division 26 shall govern installation practices under this section.

1.06 REFERENCE STANDARDS

A. Workmanship, materials and equipment together with the resultant complete and operational Building Automation System (BAS) shall be in compliance with the Authorities Having Jurisdiction (AHJ) for the project and the most restrictive of applicable local, state and federal codes and ordinances in cooperation with these plans and specifications. At a minimum, the installation shall comply with the applicable sections of the current editions in effect thirty (30) days prior to receipt of bids of the following codes:

1. ANSI/ASHRAE Standard 135: BACnet® - A Data Communication Protocol for Building Automation and Control Networks.

2. National Electric Code (NEC).

3. National Electrical Manufacturers Association (NEMA), Enclosure for Electrical Equipment, General Standards for Industrial Controls.

4. Ohio Building Code (OBC).

5. International Mechanical Code (IMC).

6. Underwriters Laboratories (UL).

7. UL-916 – Energy Management Systems (EMS).

8. UL-864/UUKL – Control Units and Accessories for Fire Alarm Systems.

1.07 WORK BY OTHERS

A. Installation of:

1. Automatic Control Dampers. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Mechanical Contractor.

2. Thermo-wells for hydronic system instrumentation.

3. Separable sockets, flow switches, flow sensors, and other in line pipe devices

4. Automatic Control Valves.

5. Airflow monitoring stations requiring modifications to ductwork other than a simple penetration into the ductwork.

6. Occupancy contacts shall be provided by the electrical contractor for integration into the BAS. It is the BAS Contractor's responsibility to wire from these contacts to appropriate BAS controller.

7. A dedicated 120 VAC circuit from breaker panel to within three (3) feet of panel is the responsibility of the Electrical Contractor. Sharing of circuit including neutral with other loads shall not be permitted.

8. CAT6 Ethernet network drops shall be installed to the BAS control panels where applicable by the Communications Contractor. The communications contractor shall terminate at the control panel to a jack within the panel. The BAS contractor shall insure that their panel has a designated location within the panel to accommodate this jack.

B. It is the BAS contractor's responsibility to assist in coordinating the locations of all sensing and final control elements associated with the BAS system. Ultimately it is the BAS contractor's responsibility to insure instrumentation is located so as to provide optimal performance and conformance to the manufacturer's installation instructions and the requirements of this specification. Where minimum distances or tolerances cannot be met the contractor is to inform the owner in writing prior to final installation.

1.08 QUALITY ASSURANCE

A. Building Automation System (BAS) Manufacturer shall be engaged full-time in the manufacture of equipment and devices of the scope, size and service required.

B. The Building Automation System (BAS) Manufacturer shall operate a Quality Management System formally certified to be in compliance with ISO 9001:2008.

C. The Building Automation System (BAS) Contractor shall specialize and have a minimum of five (5) years of experience in the design, installation, programming and operation of Building Automation Systems (BAS) of the scope, size and service specified with at least ten (10) installations with similar network architectures; and shall:

1. Be an officially authorized representative of the Building Automation System (BAS) Manufacturer with an established relationship of not less than three (3) years with at least five (5) installations of comparative size and complexity. Submittals shall document this requirement with references.

2. Project managers and project engineers shall be officially trained and certified by the Building Automation System (BAS) Manufacturer in the design, installation, programming and operation of the Building Automation System (BAS) components and have at least five (5) years of experience in DDC installation projects with point counts similar to this project and systems of the same character as this project.

3. Project technicians shall be officially trained and certified by the Building Automation System (BAS) Manufacturer in the installation, programming and operation of the Building Automation System (BAS) components.

D. The DDC BACnet® Internetwork shall be based upon and installed according to the Building Automation System (BAS) Manufacturer's standard integrated hardware and software product design and in accordance with the Manufacturer's installation and application documentation.

1.09 SYSTEM PERFORMANCE

A. Graphic Display. A minimum of 50 dynamic real-time data points within 10 seconds of the request and shall refresh with current data within 5 seconds.

B. Operator Command. The maximum time between the command of a binary or analog object by the operator and the reaction initialization by the device shall be 5 seconds.

C. Object Command. Devices shall respond to automatic command of a binary or analog object within 2 seconds.

D. Object scan. Changes of state or analog shall be transmitted such that no reporting of a value is more than 15 seconds old.

E. Alarm Response. The maximum amount of time from when an object goes into alarm until it is annunciated at the workstation shall not exceed 20 seconds.

1. Each workstation on the network shall receive alarms within 10 seconds of other workstations.

F. Program Execution. All programs in all DDC devices shall be able to execute at a minimum of at least one time every second. Program execution time shall be configurable to be consistent with the process under control.

G. Control Loop Performance. All DDC devices shall be able to execute control loops at a frequency at least one time every second. The controller shall update the process value and output generated by this calculation at this same frequency at a minimum.

H. Environmental Conditions. All Building Automation System (BAS) components provided under this specification shall operate under ambient environmental conditions of -20°C (-4°F) to 55°C (131°F) dry-bulb and 10% to 90% relative humidity, non-condensing as a minimum. Sensors and control elements shall be constructed of material suitable and rated for the media sensed under the ambient environmental temperature, pressure, humidity, and vibration conditions encountered for the installed location.

I. Power Conditions. Networked components of the Building Automation System (BAS) shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.

J. Reporting Accuracy. System shall report values with minimum end-to-end accuracy as listed in Table 1.

K. Control Stability and Accuracy. Control applications shall maintain process variables at set-point within the tolerances listed in Table 2.

1. Combined system repeatability of sensors, controllers and readout devices for a particular application shall be plus or minus 2% of full scale of the operating range.

2. Repeatability of overall combined system of sensor, controller and readout device in a control loop application will be plus or minus 5% of full scale of the operating range.

3. Long-term electronic drift shall not exceed 0.4% per year.

TABLE 1: REPORTING ACCURACY

PROCESS VARIABLE	REPORTING ACCURACY
Space Temperature	±0.5°C (±1.0°F)
Ducted Air Temperature	±1.0°C (±2.0°F)
Outdoor Air Temperature	±1.0°C (±2.0°F)
Water temperature	±0.5°C (±1.0°F)
Delta-T	±0.15°C (±0.25°F)
Relative humidity	±2% RH
Water flow	±2% of full scale
Air flow (terminal)	±10% of full scale (Note 1)
Air flow (measuring stations)	±2% of full scale
Air flow (pressurized spaces)	±3% of full scale
Air pressure (ducts)	±25 Pa (±0.1 in. WG)
Air pressure (space)	±3 Pa (±0.01 in. WG)
Water pressure	±2% of full scale (Note 2)
Electrical Power (A , W, V & PF)	±2% of reading (Note 3)
Carbon Monoxide (CO)	±10% of reading
Carbon Dioxide (CO_2)	±40 PPM

NOTE 1: Accuracy applies to 10%-100% of scale
NOTE 2: For both Absolute and Differential pressure
NOTE 3: Not including utility-provided meters

TABLE 2: CONTROL STABILITY & ACCURACY

PROCESS VARIABLE	CONTROL ACCURACY	RANGE OF MEDIUM
Air Pressure	±50 Pa (±0.2 in. WG) ±3 Pa (±0.01 in WG)	0-1.5 kPa (0-6 in. WG) -25-25 Pa (-0.1-0.1 In. WG)
Terminal Unit Air flow	±10% of full scale	
Airflow Monitoring Stations Ducted	+/- 3% of reading	0-5000 fpm
Airflow Monitoring Stations Non-ducted	+/- 5% of reading	0-5000 fpm
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3.0°F)	

Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 kPa (±1.0 in. WG)	0-1 MPa (1-150 psi) ΔP 0-12.5 kPa (0-50 in WG) ΔP
Carbon Monoxide	+/- 2% of reading	0-200 ppm 0-1000 ppm
Carbon Dioxide	+/- 3% of reading	0-2000 ppm 0-5000 ppm

1.10 SUBMITTALS

A. Equipment and systems requiring approval by the Authority Having Jurisdiction (AHJ) must comply and be approved prior to submittal. Approval shall be at the expense of the BAS Contractor. Provide a copy of all related correspondence and permits to the Owner.

B. Submit in compliance with all General Conditions of the Contract, Supplementary Conditions and General Requirements of the project and in conjunction with the requirements of this section.

C. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.

D. All submittals and documentation including complete Building Automation System (BAS) engineering design submittal & drawings, project record documents, application engineering documents and owner's & maintenance manuals shall be submitted electronically in the form of an ISO 32000 Portable Document Format (PDF). In addition three (3) paper copies formatted as described below shall be submitted. All control schematics, wiring diagrams, riser diagrams, etc. shall be formatted for A3 paper size (297mm x 420mm, 11" x 17"). All other documentation may be formatted for A4 (210mm x 297mm, 8.5" x 11").

E. Submit in writing and so delineated at the beginning of each submittal, known conflicts, substitutions and deviations from requirements of Contract Documents. Deviation from Contract Documents must be approved by Owner and/or contracting officer prior to award of contract.

F. Each submitted piece of literature and drawing shall clearly reference the applicable specification section and/or drawing that the submittal responds to. General catalogue sheets shall not be acceptable as cut sheets.

G. Submittal documentation and drawings shall consistently use the same abbreviations, symbols, nomenclature and identifiers. Each control system element shall be assigned a unique identifier pursuant with the Contract Documents.

H. Submittal documentation and drawings shall have at the beginning an index and design drawing legend.

1. Index shall list all design drawings and elements including the drawing number, sheet number, drawing title, etc.

2. Legend shall show and describe all symbols, abbreviations and acronyms used on the design drawings.

I. Provide a schedule of work indicating at a minimum the intended sequence of work, start dates and durations for individual activities, delivery dates for major materials and equipment including anticipated lead times and milestones indicating possible restraints on work by other trades or construction delays.

J. Building Automation System (BAS) Hardware Submittals.

1. A complete bill of materials of all equipment, controllers, devices and sensors to be provided and/or used indicating unique equipment identifier, unique device identifier, manufacturer, model number and quantity.

2. A Protocol Implementation Conformance Statement (PICS) including a BACnet® Interoperability Building Block (BIBB) table for each DDC device included in the submittal.

3. Manufacturer's technical data including product specification sheets, performance curves and installation/maintenance instructions. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly called out by other means.

4. Schematic diagrams for all field sensors and controllers providing floor plans indicating the locations of all sensors, devices and temperature control panels.

5. Typical sample graphics depicting typical floorplans, system graphics, tabular informational graphics etc... Any use of owner logos or other copy writed material must be approved by the owner. Color schemes and general layout are subject to approval.

6. Control enclosure details for each enclosure including panel identifier, location, physical lay-out, dimensions, instrumentation, labels, etc.

7. Wiring diagrams and schematics for each control enclosure showing and power source for each panel, secondary power and network termination as well as all individual terminations, terminal numbers, point type and mnemonic/name.

8. Wiring diagrams for all packaged equipment, motor starters, relay wiring, equipment interlock, safety circuits, etc. clearly indicating all interconnecting wiring and termination of all conductors and cables including labels of all cables and point mnemonics.

9. Wiring diagrams and schematics for each sensor.

10. A list of recommended spare parts.

K. Controlled System Submittals.

1. Riser diagram showing the physical lay-out of the entire Internetwork.

2. Riser diagram for each individual BACnet® network including the ELCN, and each BLCN and FLCN including:

a. Data link with physical characteristics and configuration.

b. Each BACnet® networked DDC device including location, service, device instance, MAC address and network number.

c. Each IP networking device including location, service and IP address.

d. Location of all interface devices including network interface jacks and workstation connections.

e. Location of all MS/TP network termination points and End-of-Line terminations.

3. A schematic control flow diagram of each controlled system showing actual physical configuration and location of all control elements including each hardware point type, controller and mnemonic.

4. A schematic wiring diagram of each controlled system showing actual physical wiring and termination of all control elements including each hardware point type, controller, mnemonic and terminal number.

5. An instrumentation list for each controlled system displaying each control element, name, manufacturer, model and product data sheet number in a tabular format.

6. A complete description of the operation of the Building Automation System (BAS) including a specific Sequence of Operation for each controlled system. Sequences of operation shall:

   a. Reference the submitted schematic of the controlled system.

   b. Refer to equipment and control devices by their specific unique identifiers pursuant with the Contract Documents and the Building Automation System (BAS) submittal package.

   c. Clearly represent actual application programming methodology and functional control operation not merely a copy of the Contract Document specified sequence of control.

   d. Include a concise description of functional system operation under specified normal and failure conditions.

   e. Include a complete hardware input and output (I/O) points schedule identifying for each point its instance, type, name/mnemonic, controller, equipment/function, location, termination, and override, alarm and display criteria.

7. Operational deviation from the specified Sequences of Operation as outlined in Contract Documents shall not be permitted under any circumstances without prior written approval.

8. A schedule of all control valves including the unique equipment identifier, valve size, dimensions and installation/maintenance clearance, model number (including pattern and connections), close-off rating, flow, CV, pressure drop, pressure rating and location. The valve schedule shall also contain actuator selection data supported by calculations of the force required to move, close and seal the valve at design conditions.

9. A schedule of all control dampers. This shall include the unique equipment identifier, unique damper identifier, damper size, pressure drop, blade configuration, orientation and axis of frame, blade rotation, location and selection criteria of actuators, nominal and actual sizes, and manufacturer and model number. The Damper Schedule shall include the SMACNA maximum leakage rate at the operating static-pressure differential.

10. A VAV box schedule indicating the VAV box identifier, minimum heating and cooling cfm values, box diameter, box affective area, AHU providing primary air, room number served, zone sensor designation (where multiple VAVs serve a common zone), and final calibration factor. The calibration factor is to be recorded after final balancing.

11. A list of recommended spare parts.

L. Network IP Requirements

1. The contractor is to submit a list of all IP network requirements to implement their control system communications requirements as designed. This is to include requests for IP addresses, UDP and TCP ports that will need to be opened to allow communications.

2. A list of all requirements necessary for offsite access to system for service personnel and owner maintenance personnel.

3. All IP communications are subject to the approval of the owner's IT personnel and must be coordinated with them.

1.11 PROJECT RECORD DOCUMENTS

A. Upon completion of installation, systems commissioning and notice of contract completion, submit record (as-built) documents. Provide three complete sets of operation and maintenance manuals in a three-ring notebook and organized by subject, by systems and by equipment with divider tabs Operation and Maintenance (O&M) manual to include the following:

1. Table of Contents

2. Names and 24-hour contact information for installing contractors and service representatives.

3. Licenses, guarantees and warrantee documentation for all equipment and systems.

4. Testing and commissioning reports and checklists.

5. Certificate of Instruction of Owner Personnel.

6. As-built revisions of all submittal data updated to reflect actual field conditions, architecture and execution.

7. Operator's manual with administrator and operator level credentials and procedures for operating the Building Automation System (BAS) including logging-on/off, handling alarms, generating points reports, trending data, overriding automatic control, changing set-points and control variables.

8. Programming manual describing the programming language structure and syntax.

9. Engineering manual describing database management and modification.

10. Installation and maintenance manuals describing how to install and configure new hardware as well as how to perform routine preventative maintenance and calibration together with corrective diagnostic troubleshooting procedures.

11. Documentation of all programs created including set-points, tuning parameters and final database.

12. Complete system database as functional at the conclusion of systems commissioning and functional testing including all graphics and images used by and/or created for Building Automation System (BAS) on electronic format as accepted by Owner.

13. Final Bill of Material with all installed parts, manufacturers, manufacturers' part numbers and ordering information.

14. A schedule of recommended spare parts with part numbers and supplier.

15. All original-issue installation and maintenance manuals, user guides, and other documentation provided with all hardware and software provided as a part of this specification.

16. Licenses, guarantees and warrantee documentation for all equipment and systems.

B. In addition to the binders, the entire Operation and Maintenance Manual shall be furnished on digital portable media. The Operation and Maintenance Manual shall be self-contained, and include all necessary software required to access the project record drawings and data sheets. A logically organized table of contents shall provide dynamic links to view and print all project record drawings and product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents. The digital media shall contain adequate space for future system update.

C. After completion of all final tests and adjustments, the contractor shall install a digital copy of the O&M manuals on the Enterprise-Level BACnet® Operator's Workstation (B-OWS). This manual shall be accessible via a dynamic link embedded in the "Home Page" of the system.

1.12 TRAINING

A. Training shall include two (2) phases.

1. Phase one shall include factory training of at least two (2) owner designated personnel.

a. The contractor is to submit a list of potential dates and locations for factory training at least six (6) weeks in advance of the training.

b. Factory training is to occur as a part of the construction process so that owner's representatives are familiar with the BAS products and their application.

c. This training shall be performed by a factory representative and shall consist of generalized training on all aspects of the configuration, programming and maintenance of the products being installed as part of this contract. This is to include but is not limited to, scheduling, alarming, graphics creation, security, network diagnostics, and troubleshooting.

d. Factory training shall be of a duration of at least four (4) days. All costs associated with travel, accommodations, and course material shall be included as part of the contractor's scope.

e. Course material used in the training shall be provided in print as well as on electronic media.

f. The training course shall be a regular course offered by the manufacturer as part of a certified factory training program.

2. Phase two shall include on-site site specific training.

a. All training at the site shall utilize specified manuals, as-built documentation, and the on-line help utility. All training sessions shall be videotaped. Submit two copies of the training session(s) prior to project contract completion.

b. Trainers shall be qualified contractor personnel familiar with all aspects of the BAS system as installed on site.

c. Training shall be specific to the site.

d. All training materials and equipment (i.e. projectors, training PCs etc.) shall be provided by the contractor. Coordinate with the building owner for site training location and personnel who will be attending.

e. Upon completion of the work and acceptance by the Owner, provide six four-hour periods of instruction to the Owner's operating personnel who have responsibility for operating and maintaining the BAS system. Provide two periods of training at the end of Construction Phase and two periods at the beginning of the first winter, and the remaining two at the beginning of the first summer. The BAS Manufacturer shall make available to the Owner regularly scheduled training courses for the ongoing training of the Owner's operating personnel.

1.13 WARRANTY

A. The Building Automation System (BAS) Manufacturer shall warranty all DDC controllers to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit's performance specifications for a period of five (5) years at a minimum.

1. Sensors and field components integral to DDC controllers shall be warrantied to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit's performance specifications for a period of one (1) years at a minimum.

B. The Building Automation System (BAS) Contractor shall warranty the installation of all other materials and labor to be free of defects under normal expected service and use for a period of one (1) year from the date of final acceptance.

C. Building Automation System (BAS) failures during the installation warranty period shall be adjusted, repaired or replaced at no additional cost or reduction in service to the Owner. Except in the event of property loss or damage, warranty service shall be provided during regular working hours Monday through Friday. The Building Automation System (BAS) Contractor shall respond to failure notifications from the Owner within twenty four (24) hours. Repair or replacement of failed components will be schedule as soon as practical.

D. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user digital media. At the end of the warranty period, the Contractor shall prepare three duplicate copies of all control software on digital media. Two copies, complete with hardware and software interfaces and full down-line reloading instructions, shall then be turned over to the Owner.

E. The Building Automation System (BAS) Contractor shall maintain an on-site record of all work done, all items removed from site, all items returned to the site, all new replacement items installed and all remedial programming, database entry work and recalibration undertaken including software revisions installed as a result of Warranty service.

F. The Building Automation System (BAS) Contractor shall maintain an off-site record of the most recent database and control system drawings for restoration in the event of a catastrophic system failure.

1.14 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project specific software and documentation shall become the Owner's property including but not limited to graphics, record drawings, database, application programming code and documentation upon project acceptance.

B. The Owner retains the right to allow and/or prohibit access to all aspects of the system solely at their discretion.

1.15 MATERIAL DELIVERY AND STORAGE

A. The contractor is to coordinate with the general contractor all on-site laydown and material storage locations.

B. The contractor is to keep a current list of all on-site stored material.

C. The contractor is to provide adequate documentation of any material stored off-site and listed as stored material in the AIA billing documents.

D. Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

END OF PART 1

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. All DDC devices shall be tested, certified, clearly stamped and listed by the BACnet® Testing Laboratories (BTL) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

B. The order of manufacturers does not indicate preference. Inclusion on this list does not guarantee acceptance of products or installation. Building Automation Systems (BAS) shall comply with all of the requirements of this specification.

C. The following are approved Building Automation System (BAS) manufacturers:

1. Automated Logic
2. Reliable Controls® Corporation
3. Honeywell Alerton System
4. Johnson Controls
5. Schneider Electric
6. Automation Displays, Inc. (Firefighter's Smoke Control Override Panel only)
7. HR Kirkland Co., Inc. (Firefighter's Smoke Control Override Panel only).
8. Light Engineered Displays Inc. (Firefighter's Smoke Control Override Panel only).

D. All Building Automation System (BAS) networked devices specified herein including advanced operator workstations, operator workstations, controllers and routers shall be provided by one of the manufacturers listed above.

1. OEM and/or private-labelled controllers or software manufactured or developed by a third-party and labelled or otherwise represented as being a product of one of the allowable manufacturers listed above shall not be accepted under this specification.

E. Other non-networked system components specified herein (including sensors, valves, dampers, etc.) need not be manufactured by the above manufacturers.

F. The Building Automation System (BAS) Manufacturer product line selected shall be the most current and complete offering from the manufacturer and shall currently be actively manufactured and supported at the time that this project is bid.

G. This project shall not be used as a test site. First release and test version hardware, software and firmware shall not be implemented on this project under any circumstances.

H. Building Automation System (BAS) devices and spare components or equivalent shall be readily available for a minimum of five (5) years after the completion and final acceptance of this project.

2.02 NETWORK COMMUNICATIONS

A. The Building Automation System (BAS) as provided and installed under this specification shall comprise a BACnet® Internetwork. All communication shall conform to ANSI/ASHRAE Standard 135, BACnet®.

B. Each individual DDC device shall provide a communication port for the connection of an operator workstation. The Building Automation System (BAS) contractor shall provide as part of this contract the any necessary specialized hardware (cables, connectors, converters etc.) to facilitate this connectivity.

C. The Building Automation System (BAS) shall be modular in nature and implemented in such a manner that it can be expanded in both capacity and functionality through the addition of DDC controllers, devices and wiring. Expansion shall not require operator interface or configuration hardware additions, software revisions or hardware, operating system/feature licensing.

D. All Building Automation System (BAS) BACnet® networked devices with Real-Time Clocks (RTCs) shall utilize the BACnet® Time Synchronization service. The System shall automatically synchronize system clocks from a designated Time Master periodically via the Internetwork. The System shall also automatically adjust for configurable Daylight Savings Time and Standard Time as applicable.

2.03 ENTERPRISE-LEVEL BACNET® OPERATOR WORKSTATION (B-OWS)

A. Not required under this project's scope.

2.04 BACNET® ADVANCED OPERATOR WORKSTATION (B-AWS)

A. The BACnet® Advanced Operator Workstation provides complete configuration, monitoring, modification and operation of the entire Building Automation System (BAS) by advanced building operators and technicians.

B. BACnet® Advanced Operator Workstation software shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a B-AWS and shall be certified and listed by the BACnet® Testing Laboratories (BTL) as a B-AWS prior to the bid date for this project. BTL product listings are available from BACnet® International at (http://www.bacnetinternational.net/btl/).

C. BACnet® Advanced Operator Workstation shall reside on the BLCN using the BACnet®/IP data link as specified in ANSI/ASHRAE Standard 135.

D. Security

1. Each operator shall be required to log on to the system with a unique user name and password in order to view, edit, add or delete data.

a. System security permissions shall be multilayered and defined for each individual operator to restrict/permit day-to-day operations and system configuration.

b. An administrator-level operator shall have the ability to configure credentials for all other operators.

c. Each operator shall be automatically logged-off of the system after a configurable period of inactivity.

d. Security data shall be stored in an encrypted format.

E. Database Back-up & Restore.

1. Each workstation shall provide operator interface and off-line storage of system information. An operator with the proper permissions shall be able to back-up, restore and/or clear the database from any device on the Internetwork.

a. The workstation shall perform automated network back-up of runtime databases in all devices on the BACnet® internetwork according to operator configurable schedule and storage directory structure.

F. System Configuration.

1. The workstation shall provide a complete engineering tool for the configuration of the system. This shall allow for future system changes under proper password protection including dynamic creation, deletion and modification of all configuration parameters, programs, graphics, trend logs, alarms, schedules and every BACnet® object used in the installed system.

G. Online Help.

1. Provide a context-sensitive online help system to assist the user in operation and modification of the system. Online help shall be available for all system applications and shall provide the relevant data for the active window or screen. Additional help shall be available through the use of hypertext.

H. System Diagnostics.

1. The workstation shall be provided with fully automatic verification of internetwork communication. In the event of communications failure, the system shall automatically Alarm the condition. B-AWS Software shall be capable of remote annunciation to printer, pager and e-mail.

I. Graphical User Interface (GUI).

1. The operator interface shall be graphically oriented

a. All color graphic displays shall be dynamic with current point data automatically updated from the BACnet® internetwork to the workstation without operator intervention.

b. With the proper credentials the operator shall be able to manually adjust all data point values (hardware or software) in the system, adjust control loop parameters, schedules and command points to manual override, timed override and automatic mode.

c. Operators shall have the ability to dynamically create messages saved as text files on the B-AWS associated with individual objects on a display or the display itself. These text files may be viewed and modified by other operators during other sessions.

d. The windowing environment of the workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, and/or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

e. Operator shall be able to easily navigate between the graphic displays and shall be able to individually change the size and location of the displays on the screen.

f. B-AWS software shall support at a minimum BMP, GIF, TIF, JPG, EMF, PNG, SWF and DIB graphic file formats and allow for the use of custom animation objects and URL hyperlinks in each display.

g. The operator shall have the ability to generate custom dynamic images for graphical representation of system design and system parameters. Graphic images may reside on a workstation or server; however, all dynamic data and attributes must reside in each controller.

h. Library of standard HVAC graphic components consistent with the delivered graphics shall be available to the Owner including all of the equipment and standard symbols used in a file format compatible with the B-AWS software.

J. Alarm Processing.

1. The workstation shall display and log alarms and events from any BACnet® object in the system and shall support operator configuration of the alarm limits, differentials, states and reactions for each object in the system.

a. Alarm Classification. System shall provide a minimum of 50 configurable notification classes and 100 configurable alarm priorities.

b. Alarm and Event Log. The operator shall be able to view all system alarms from any location in the internetwork. With the proper credentials, an operator shall be able to acknowledge and clear alarms. Alarm and Event Log shall be configurable per workstation and shall display at a minimum alarm time, received time, state, notification class, priority, message, source, time acknowledged, acknowledged by user and action.

1) Acknowledged and Cleared alarms shall be saved to the hard disk of the workstation.

c. Alarm Messages. Alarm messages shall use the English language name for the object in alarm in such a way that the source, location and nature of the alarm is easily understood without relying upon mnemonics or object instances.

1) Alarm messages shall be fully customizable in size, content, behavior and sound.

d. Alarm Actions. The operator shall be able to configure any of the following automatic alarm actions per workstation.

1) Logging.

2) Printing.

3) Starting programs or routines.

4) Displaying messages.

5) Paging.

6) Audible annunciation.

7) Displaying specific graphical displays or files.

K. Scheduling.

1. The workstation shall support viewing and with proper user credentials, modification, creation and deletion of binary, analog and multistate BACnet® Schedule objects and parameters.

a. The schedule objects shall reside in each individual device. Workstation or server-based scheduling shall not be acceptable.

b. Each schedule shall display the scheduled transitions for the calendar week. Each calendar day shall support up to a minimum of ten (10) transitions and each transition shall be modifiable via the workstation graphically or via manual entry.

c. Display a monthly calendar allowing for indication and modification of Exception Schedules for any calendar day.

1) Each Exception Schedule and holiday shall be individually configurable including name, priority, transition values and times.

2) The operator shall have the ability to configure Exception Schedules to be active on specific dates, date ranges, recurring date patterns or as commanded by BACnet® Calendar objects or other override objects.

L. Trend Logs.

1. The workstation shall support both the BACnet® Trend Log and the BACnet® Trend Log Multiple standard objects for defining custom trend logs for any object in the system. This definition shall include interval, length, start time and end time.

    a. The trend data shall be sampled and stored in each individual BACnet® device where the object is stored. The workstation or another field level integration platform shall not be required for storage of custom trend logs.

    b. All long-term data archival to hard-disk shall be performed by a BTL-Listed BACnet® device dedicated for this service.

    c. The workstation shall display all trend log data in a tabular and graphical format.

    d. All trend log data shall be able to be exported as a CSV or XLS and printed.

    e. The workstations shall display trend log data from controllers and archived BACnet® data from the archive server database seamlessly, in the same trend log display.

M. Runtime Logs.

1. The workstation shall support logging and reporting of runtime for every binary object in the system.

    a. Runtime data shall be sampled and stored in each individual BACnet® device where the object is stored using standard BACnet® objects and published properties. The workstation shall not be required for storage of custom runtime logs.

    b. At a minimum, the Runtime data shall include: total accumulated active time, total accumulated active transitions, and active transitions for the current day, timestamp and duration for each change of state for the last 100 transitions.

N. Object and Property Status and Control.

1. The workstation shall provide a method for the operator to view and if permitted modify the status and present value of any standard object and property in the system.

    a. The operator shall be able to build custom reports manually or by performing wildcard searches for object instances, mnemonics or names.

2.05 EMBEDDED BACNET® OPERATOR WORKSTATION (B-OWS)

A. The embedded BACnet® Operator Workstation (B-OWS) provides day-to-day monitoring and basic operation of the Building Automation System (BAS). The embedded BACnet® Operator Workstation is not designed for configuration of the System.

B. The embedded BACnet® Operator Workstations shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for both a B-OWS and a B-BC and shall be certified and listed by the BACnet® Testing Laboratories (BTL) as both a B-OWS and a B-BC prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

C. Embedded BACnet® Operator Workstations shall reside on the ELCN or the BLCN using the BACnet®/IP data link as specified in ANSI/ASHRAE Standard 135 Annex J.

D. Each embedded BACnet® Operator Workstation shall store the entire device database and all necessary Graphical User Interface (GUI) resources including animations locally on the device. Web-enabled applications that require system graphics to be stored on the client machines or servers shall not be acceptable.

E. Security.

1. Each operator shall be required to log on to the system with a unique user name and password in order to view, edit, add or delete data.

    a. System security permissions shall be multilayered and defined for each individual operator to restrict/permit day-to-day operations and system configuration.

    b. Each operator shall be automatically logged-off of the system after a configurable period of inactivity.

    c. Security data shall be stored and transmitted in an encrypted format.

F. Graphical User Interface (GUI).

1. The operator interface shall be graphically oriented.

    a. All color graphic displays shall be dynamic with current point data automatically updated from the BACnet® internetwork to the embedded workstation without operator intervention.

    b. The operator with the proper credentials shall be able to manually adjust all data point values (hardware or software) in the system, adjust values of control loops, and command points to manual override, timed override and automatic mode.

    c. Operators shall have the ability to dynamically create messages saved a text files on the embedded B-OWS associated with individual objects on a display or the display itself. These text files may be viewed and modified by other operators during other sessions.

G. Alarm Processing.

1. The embedded workstation shall display and log alarms and events from any BACnet® object in the system and shall support operator configuration of the alarm limits, differentials, states and reactions for each object in the system.

a. Alarm Classification. System shall provide a minimum of 50 configurable notification classes and 100 configurable alarm priorities.

b. Alarm and Event Log. The operator shall be able to view all system alarms from any location in the internetwork. With the proper credentials, an operator shall be able to acknowledge and clear alarms. Alarm and Event Log shall display at a minimum alarm time, received time, state, notification class, priority, message, source, time acknowledged, acknowledged by user and action.

c. Alarm Messages. Alarm messages shall use the English language name for the object in alarm in such a way that the source, location and nature of the alarm is easily understood without relying upon mnemonics or object instances.

1) Alarm messages shall be fully customizable in size, content and behavior.

d. Alarm Actions. The operator shall be able to configure any of the following automatic alarm actions per workstation.

1) Logging.

2) Printing.

3) Starting programs or routines.

4) Displaying messages.

5) Paging.

6) Audible annunciation.

7) Displaying specific graphical displays or files.

H. Scheduling.

1. The embedded workstation shall support viewing and with proper user credentials modification of BACnet® binary, analog and multistate Schedule objects and parameters.

a. The schedule objects shall reside in each individual device. Workstation or server-based scheduling shall not be acceptable.

b. Each schedule shall display the scheduled transitions for the calendar week. Each calendar day shall support up to a minimum of ten (10) transitions and each transition shall be modifiable via the workstation graphically or via manual entry.

c. Display a monthly calendar allowing for indication and modification of Exception Schedules for any calendar day.

1) Each Exception Schedule and holiday shall be individually configurable including name, priority, transition values and times.

2) The operator shall have the ability to configure Exception Schedules to be active on specific dates, date ranges, recurring date patterns or as commanded by BACnet® Calendar objects or other override objects.

I. Trend Logs.

1. The embedded workstation shall support both the BACnet® Trend Log and the BACnet® Trend Log Multiple standard objects for defining custom trend logs for any object in the system. This definition shall include interval, length, start time and end time.

a. The trend log data shall be sampled and stored in each individual BACnet® device where the object is stored. The workstation shall not be required for storage of custom trend logs.

b. All long-term data archival to hard-disk shall be performed by a BTL-Listed BACnet® device dedicated for this service.

c. The workstation shall display all trend log data in a tabular and graphical format.

d. All trend log data shall be able to be exported as a CSV or XLS and printed.

e. The embedded workstations shall display trend log data from controllers and archived BACnet® data from the archive server database seamlessly, in the same trend log display.

J. Runtime Logs.

1. The embedded workstation shall support logging and reporting of runtime data for every binary object in the system.

a. Runtime data shall be sampled and stored in the individual BACnet® device where the object is stored using standard BACnet® objects and published properties. The workstation shall not be required for storage of custom runtime logs.

b. At a minimum the Runtime data shall include: total accumulated active time, total accumulated active transitions, and active transitions for the day, timestamp and duration for each change of state for that last 100 transitions.

2.06 BACNET® DATA ARCHIVE SERVER

A. Acquisition of trend log data for archival and long-term secure storage of trend log data shall be performed by a BTL-Listed BACnet® device dedicated to this service. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

B. BACnet® Data Archive Server shall reside on the BLCN using the BACnet®/IP data link as specified in ANSI/ASHRAE Standard 135 Annex J.

C. BACnet® Data Archive Server shall support at a minimum the following BACnet® Interoperability Building Blocks (BIBBs) as supported by the submitted PICS:

1. Data Sharing-ReadProperty-A (DS-RP-A).

2. Data Sharing-ReadProperty-B (DS-RP-B).

3. Data Sharing-ReadProperyMultiple-A (DS-RPM-A).

4. Data Sharing-ReadProperyMultiple-B (DS-RPM-B).

5. Data Sharing-WriteProperty-A (DS-WP-A).

6. Trending-Automated Trend Retrieval–A (T-ATR-A).

7. Trending-Automated Multiple Value Retrieval-A (T-AMVR-A).

8. Trending-Archival-A (T-A-A).

9. Device Management-Dynamic Device Binding-A (DM-DDB-A).

10. Device Management-Dynamic Device Binding-B (DM-DDB-B).

11. Device Management-Dynamic Object Binding-B (DM-DOB-B).

D. At a minimum, the BACnet® data archive server shall be capable of performing the following:

1. Automatically retrieving the data from all BACnet® Trend Log and BACnet® Trend Log Multiple objects from any BACnet® device communicating on the internetwork without user-intervention.

2. Automatically manage the connection to the internetwork based upon configurable data acquisition thresholds; retrieving data only when necessary rather than streaming data.

3. Generate a standard, secure SQL database accessible by third-party applications.

4. Operate as a Microsoft Windows service.

5. Archived data shall be limited only by SQL license and hard disk space available.

6. BACnet® Advanced Operator Workstations (B-AWS), BACnet® Operator Workstations (B-OWS) and enterprise level BACnet® web servers shall display trend log data from controllers and archived BACnet® data from the archive server database seamlessly in the same trend log display.

2.07 CONTROLLERS

A. BACnet® Compliance. All DDC controllers shall be tested, certified, clearly stamped and listed by the BACnet® Testing Laboratories (BTL) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

B. Specification Compliance. All DDC controllers shall comply with the general requirements of all parts of this specification.

C. Application. Each individual mechanical system or piece of equipment shall be controlled by no more than one (1) dedicated controller with sufficient hardware and database capacity such that it shall be connected to all field devices and sensors associated with that system and/or piece of equipment.

1. Distributed control of one (1) single piece of mechanical equipment shall not be performed by multiple controllers.

D. Memory. Each controller shall have sufficient memory to support its operating system, database, and programming requirements. Battery/capacitor shall maintain programming and clock memory and functions for a minimum of 72 hours.

1. Each controller shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. All local level application programs shall be installed on individual controllers in non-volatile memory.

E. Updates. All controllers shall permit simple operating system firmware updates at any time after installation, utilizing the BACnet® network. Operating system firmware that requires chip replacement or flash modification will not be acceptable.

F. Data Sharing. Each controller shall be capable of locally executing global strategies for the Building Automation System (BAS) based on information from any object in the internetwork. Control systems that require a higher-level host processor for update, time stamps, global point data, COS transfer, on-line control instruction, or communications control between panels shall not be acceptable.

G. Serviceability. Each DDC controller shall be provided with diagnostic LEDs for power, communication and processor. All wiring connections shall be made to field-removable, modular terminal strips.

H. Universal Inputs. All hardware inputs on all controllers shall be of the universal type and shall support the following physical characteristics at a minimum.

1. Dry-contact.

2. Pulse/Pulse-width accumulation.

3. Resistance.

4. Voltage.

5. Current.

6. 24 VAC over-voltage protection.

I. Universal Outputs. All controllers with universal type hardware outputs and shall support the following physical characteristics at a minimum:

1. Contact closure.

2. Analog/Modulating.

3. 24 VAC over-voltage and short protection.

J. Operator Override. All BACnet® Building Controllers (B-BC) shall support operator-initiated timed overrides of hardware and software objects with user-configurable override periods. When the override period has expired, the controller shall automatically return the object to the automatic state without any additional action on the part of the Operator.

1. The timed override functionality shall exist entirely in the controller. A workstation shall not be required for the execution of the time period nor for returning the object to automatic.

K. Database. Programming, configuration and modification shall be accomplished via the Internetwork from the B-AWS. The complete operational database and application program shall reside in each individual controller.

1. All controllers delivered as a part of this specification shall be configured using one (1) common B-AWS. Devices that require custom applications for configuration shall not be acceptable.

2. The controllers shall function in a real-time, multi-tasking networked operating environment; able to display database values, programs, and control loops in real-time while functional and online using the B-AWS. The user shall be able to add, delete, or modify objects on-line as required without taking the controller offline. The programming shall provide all the necessary mathematics, logic, utility and control functions necessary to execute the specified sequence of control.

L. Programmability. All controllers shall be freely-programmable and support custom control strategies, programs and databases that are completely modifiable over the BACnet® Internetwork once installed.

1. All controllers delivered as a part of this specification shall be programmed using one (1) common programming language, means and method via the B-AWS. Devices that require custom applications for configuration shall not be acceptable.

2. Control systems that exclusively utilize configurable-only ‘canned’ programs or programmable read only memory (PROM) level application programming are not acceptable.

M. Alarm Processing. A controller’s ability to report alarms shall not be affected by either operator activity, execution of programs or communications with other controllers on the network.

N. Scheduling. All controllers shall support the standard BACnet® Schedule and BACnet® Calendar objects.

1. Schedule objects shall reside in each individual device. Workstation or server-based scheduling shall not be acceptable.

2. BACnet® Schedule objects shall support binary, analog, and multi-state values.

3. Each calendar day shall support up to a minimum of ten (10) transitions.

4. BACnet® Schedule objects shall be able to directly command any BACnet® object in the internetwork without requiring custom programming.

5. Exception Schedules shall be configurable for any calendar day.

   a. Each Exception Schedule and holiday shall be individually configurable including name, priority, transition values and times.

   b. The operator shall have the ability to configure Exception Schedules to be active on specific dates, date ranges, recurring date patterns or as commanded by BACnet® Calendar objects or other override objects.

O. Trending. All BACnet® Building Controllers (B-BC) shall support both standard BACnet® Trend Log and BACnet® Trend Log Multiple objects.

P. Runtime Logs. All controllers shall support logging and reporting of runtime for every binary object in the system.

1. Runtime data shall be sampled and stored in each individual BACnet® device using standard BACnet® objects and published properties. A workstation shall not be required for storage of custom runtime logs.

2. Runtime data shall include at a minimum total accumulated active time, total accumulated active transitions, active transitions today, timestamp and duration for each change of state for the previous 100 transitions.

Q. Workstation Connection. All controllers shall support a communications port for connection of a portable operator's terminal using a BACnet® physical data link.

R. Communicating Sensors. All controllers shall support and be capable of monitoring and controlling a network of communicating space sensors without consuming physical hardware input/output points on the device.

2.08 BUILDING LEVEL CONTROLLERS

A. Building Level Controllers. A dedicated building-level controller shall be provided for the execution of global strategies and for each large point-count major mechanical system and/or piece of equipment.

1. Any application exceeding eight (8) inputs or eight (8) outputs shall not be considered a terminal unit application and shall require a dedicated field-level equipment controller or a building-level controller.

B. BACnet® Device Profile. All building level controllers shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a BACnet® Building Controllers (B-BCs) and shall be certified and listed by the BACnet® Testing Laboratories (BTL) as a B-BC prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

C. BACnet® Networking. Building level controllers shall reside on the ELCN, BLCN or FLCN using the BACnet®/IP, BACnet®/Ethernet or MS/TP data links as specified in ANSI/ASHRAE Standard 135.

D. Communication. Building level controllers shall support the following communications requirements at a minimum:

1. Client and Server BACnet® Subscribe Change of Value (COV) Service.

2. Client and Server BACnet® Read Property Multiple (RPM) Service.

3. BACnet® transmit and receive frame segmentation.

4. Post-installation, field-configurable maximum information frames, APDU frame timeout, APDU segment timeout and APDU retries.

E. Alarm Annunciation. Building level controllers shall support SMTP and provide stand-alone remote annunciation of alarms via e-mail without additional hardware, B-OWS, B-AWS or web-server.

2.09 BUILDING LEVEL EQUIPMENT CONTROLLERS

A. Building-level equipment controllers shall be provided as required to achieve the performance prescribed in this specification for the execution of indoor environmental quality control and monitoring strategies through the control of mechanical systems or pieces of equipment as designated.

B. BACnet Device Profile. Building-level equipment controllers shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L a minimum of 30 days prior to the bid date for this project as follows:

a. BACnet Building Controller (B-BC)

C. BACnet Networking. Building-level equipment controllers shall natively support the following BACnet data links as specified in ANSI/ASHRAE Standard 135 and in compliance with the following physical layer standards at a minimum.

1. BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.

a. ISO 8802.3 Ethernet (10/100 BaseT),

b. ISO 8802.3af PoE (10/100 BaseT), or

c. ISO 8802.3b/g/n Wi-Fi.

2. ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.

a. ISO 8802.3 Ethernet (10/100 BaseT),

b. ISO 8802.3af PoE (10/100 BaseT), or

c. ISO 8802.3b/g/n Wi-Fi.

3. Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.

a. EIA-485.

D. Modbus Networking. Building-level equipment controllers shall natively support the following Modbus data links in compliance with the following physical layer standards at a minimum:

1. Modbus/TCP as a Master or Slave.

a. ISO 8802.3 Ethernet (10/100 BaseT),

b. ISO 8802.3af PoE (10/100 BaseT), or

c. ISO 8802.3b/g/n Wi-Fi.

2. Modbus/RTU as a Master or Slave.

a. EIA-485.

E. Power & Noise. In addition to the power and noise requirements for all controllers, building-level equipment controllers shall also support the following physical power link:

1. ISO 8802.3af PoE.

F. Universal Inputs. Building-level equipment controllers shall be provided with a minimum of six (6) software-selectable universal inputs dedicated for the connection of field devices compliant with the requirements for all controllers.

1. The total number of universal inputs connected to the building-level equipment controller shall be capable of being increased to a minimum of 18.

G. Integral Sensors. In addition to universal inputs dedicated for the connection of field devices, building-level equipment controllers shall support the following integral sensors at a minimum:

1. Temperature.

a. Resolution: ± 0.1 °C (0.18 °F).

b. Accuracy: ± 0.1 °C (0.18 °F).

2. Relative Humidity.

a. Range: 10-90 %RH.

b. Resolution: ± 0.1 %RH.

c. Accuracy: ± 3 %RH.

3. CO2.

a. Range: 400-2000 ppm.

b. Accuracy: ± 35 ppm.

c. Non-Linearity: < 1% of full scale.

d. Technology: Non-Dispersive Infrared Optical Sensor.

4. Occupancy.

a. Range: 5 m (16.4').

b. Angle: 100° horizontal/82° vertical.

c. Technology: Passive Infrared Radiation (PIR).

5. All integral sensors shall comply with the System performance criteria detailed elsewhere in this specification.

H. Outputs. Building-level equipment controllers shall be provided with a minimum of six (6) jumper-selectable physical outputs dedicated for the connection of field devices. In addition to the requirements for universal outputs on all controllers, building-level equipment controllers shall also support at a minimum the following physical characteristics:

1. Solid state relay (500 mA @ 24 VAC/VDC).

a. The act of switching must not produce an audible noise discernable to the occupants of the space where the device is installed.

2. The total number of physical outputs connected to the building-level equipment controller shall be capable of being increased to a minimum of 16.

2.10 BUILDING-LEVEL OPERATOR DISPLAYS

A. Building-level operator displays shall be provided as required to complement building-level equipment controllers with a comprehensive local interface for the System.

1. Building-level operator displays shall be required to comply with all the requirements for building-level equipment controllers in addition to those prescribed in this specification clause.

B. BACnet. All building-level operator displays shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L prior to the bid date for this project as follows:

1. BACnet Building Controller (B-BC), and

2. BACnet Operator Display (B-OD).

C. Integral Operator Display. Each building-level operator display shall comply with the following minimum criteria:

1. Full-color Wide Quarter VGA (WQVGA) Display.

2. Thin Film Transistor (TFT) Projective Capacitive Touch (PCAP) interface

2.11 FIELD-LEVEL EQUIPMENT CONTROLLERS

A. BACnet® Field Level Equipment Controllers. One (1) dedicated field-level equipment controller shall be provided for the execution of global and local strategies for each mechanical system and/or building system piece of equipment.

1. Distributed control of one piece of mechanical equipment shall not be performed by multiple DDC controllers.

2. Multiple pieces of mechanical equipment comprising one mechanical system may be controlled by a single DDC controller provided that all of the points associated with the equipment are hosted by the controller.

3. Any application exceeding eight (8) inputs or eight (8) outputs shall not be considered a terminal unit application and shall require a dedicated field-level equipment controller or a building-level controller.

4. All field-level equipment controllers provided shall be the same controller model and manufacturer.

B. BACnet® Device Profile. All field-level equipment controllers shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a BACnet® Building Controllers (B-BCs) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

C. BACnet® Networking. Field-level equipment shall reside on the BACnet® MS/TP data link as specified in ANSI/ASHRAE Standard 135.

D. BACnet® MS/TP Slave Device Support. Field-level equipment controllers shall be capable of automatically discovering BACnet® slave devices and shall be capable of serving as a proxy for BACnet® slave devices.

E. Communication. Field-level equipment controllers shall support the following communications requirements at a minimum:

1. Client and Server BACnet® Subscribe Change of Value (COV) Service.

2. Client and Server BACnet® Read Property Multiple (RPM) Service.

3. BACnet® transmit and receive frame segmentation.

4. Post-installation, field-configurable maximum information frames, APDU frame timeout, APDU segment timeout and APDU retries.

2.12 TERMINAL UNIT CONTROLLERS

A. Terminal Unit Controllers. One (1) dedicated terminal controller shall be provided for the execution of local strategies and for each mechanical terminal unit.

1. Any application with fewer than eight (8) inputs and eight (8) outputs may be considered a terminal unit application and shall require a dedicated terminal unit controller.

2. All terminal units with a common application shall be provided with the same unitary controller model and manufacturer.

B. BACnet® Device Profile. All terminal unit controllers shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a BACnet® Building Controllers (B-BCs) and shall be certified and listed by the BACnet® Testing Laboratories (BTL) as a B-BC prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

C. BACnet® Networking. Terminal unit controllers shall reside on the FLCN using the BACnet® MS/TP data link as specified in ANSI/ASHRAE Standard 135 in compliance with the following requirements at a minimum:

1. Automatically detect the baud of the MS/TP network and then configure the device's communication baud to match that of the MS/TP network.

2. Be capable of efficiently communicating at a baud of 76.8 Kbps under normal network operational conditions with all devices executing the specified sequences of operation at the specified performance criteria.

D. Communication. Terminal unit controllers shall support the following communications requirements at a minimum:

1. Client and Server BACnet® Subscribe Change of Value (COV) Service.

2. Client and Server BACnet® Read Property Multiple (RPM) Service.

3. BACnet® transmit and receive frame segmentation.

4. Post-installation, field-configurable maximum information frames, APDU frame timeout, APDU segment timeout and APDU retries.

2.13 SPACE MOUNTED TERMINAL UNIT CONTROLLERS

A. As required, one (1) dedicated space mounted terminal controller shall be provided for the execution of local indoor environmental control and monitoring strategies and for each mechanical terminal unit.

1. Space mounted terminal controllers shall be aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space.

2. All terminal units with a common application shall be provided with the same unitary controller model and manufacturer.

3. For space mounted controllers, any unitary application with between four (4) and eight (8) inputs or between four (4) and eight (8) outputs shall be considered an advanced terminal unit application.

B. BACnet® Device Profile. All space mounted terminal controllers shall be certified and listed by the BACnet® Testing Laboratories (BTL) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

1. Advanced application space mounted terminal controllers shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a BACnet® Advanced Application Controllers (B-AACs).

C. BACnet® Networking. Space mounted terminal controllers shall reside on the FLCN using the BACnet® MS/TP data link as specified in ANSI/ASHRAE Standard 135 in compliance with the following requirements at a minimum:

1. Be capable of efficiently communicating at a baud of 76.8 Kbps under normal network operational conditions with all devices executing the specified sequences of operation at the specified performance criteria.

2.14 COMMUNICATING SPACE SENSORS

A. Communicating Space Sensors. All controllers of the Building Automation System (BAS) as provided will support networked, communicating space sensors for monitoring of internal environmental conditions and low-level operator interface without consuming hardware inputs/outputs on the host DDC controller.

1. Communicating space sensors shall be aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space.

2. All communicating space sensors shall be developed, manufactured and supported by the same manufacturer of the Building Automation System (BAS) components specified herein and provided by the Building Automation System (BAS) Contractor.

3. A minimum of four (4) communicating sensors shall be supported by each DDC controller.

4. Space mounted terminal unit controllers with fewer than four (4) inputs and four (4) outputs shall not be required to support communicating space sensors.

B. System Interface. Communicating space sensors shall be capable of providing access to the Internetwork for an operator workstation and/or portable operator terminal.

2.15 WIRELESS TEMPERATURE SENSORS

A. Wireless temperature sensors shall not be used.

2.16 AUTOMATIC CONTROL DAMPERS

A. Automatic Control Dampers. All automatic control dampers provided as a part of this specification shall bear the SMACNA seal in compliance with the SMACNA Certified Ratings Programs.

B. Opposed Blade Style. Unless otherwise scheduled on the contract drawings, opposed blade dampers shall be as follows:

1. Opposed blade dampers shall be used for all mixing, volume throttling and discrete airflow control applications installed in outdoor, relief, exhaust, and/or supply air streams as well as all applications immediately upstream of critical equipment and all ducted outlets.

2. Blade edges shall be interlocked and blade seals shall be compressible at all contact points. Channel frames shall also be provided with jamb seals.

C. Parallel Blade Style. Unless otherwise scheduled on the contract drawings, parallel blade dampers shall be as follows:

1. Parallel blade dampers shall be used in two-position, mechanical ventilation and exhaust, combustion intake and exhaust applications as well as applications where the damper constitutes the primary source of total system pressure loss or where greater control is required at the upper end of the airstream volume operating range.

2. Parallel blade dampers may also be used for outdoor and return air mixing applications as scheduled and if arranged to direct the airstreams toward one another.

D. Sections. Individual damper sections shall not exceed 125 cm (48”) wide and 150 cm (60”) tall. Applications requiring larger dampers shall be achieved by combining single damper sections. One (1) actuator, at a minimum, shall be provided per section.

E. Frame. Damper frame construction shall be a minimum of 13 gauge galvanized steel channel or 3 mm (1/8”) extruded aluminum with reinforced corner bracing and continuously welded.

F. Blades. Damper blades shall not exceed 20 cm (8”) in width or 125 cm (48”) in length. Blades are required to be suitable for medium velocity performance of 10 m/s (2000 fpm) at a minimum.

1. Damper blades and baffles shall be fabricated of minimum 16 gauge steel with corrosion resistant galvanized finish or 2 mm (0.08”) extruded aluminum at 15 cm (6”) width.

2. Damper blades mounted vertically shall be supported by thrust bearings

3. Dampers shall have a minimum of four brakes running the entire length.

G. Seals. All damper blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. Blade seals shall provide for a maximum leakage rate of 50 L/s per m2 (10 cfm per ft2) at 1000 Pa (4 inwc) differential pressure. Provide air foil blades suitable for a wide-open face velocity of 7.5 m/s (1500 fpm).

1. Damper leakage shall be certified in accordance with SMACNA Standards.

H. Bearings. Damper shaft bearings shall be as recommended by manufacturer for application; nylon, cycoloy, oilite® style oil impregnated sintered bronze or better.

I. Shafts. Shafts shall be a minimum of 12 mm (1/2") diameter and be welded or riveted to the blade.

J. Outdoor Suitability. All outdoor air damper components shall be suitable for applications operating in the temperature range of -40˚C (-40˚F) to 75˚C (167˚F).

K. Linear Characterization. All Automatic Control Dampers in modulating applications shall be sized so as to achieve linear airflow characteristics.

L. Operating Linkages and Damper Accessories:

1. All operating linkages and/or damper accessories required for installation and application in accordance with specification design intent and manufacturer's installation procedures shall be provided.

2. Operating linkages provided external to dampers (crank arms, connecting rods, shaft extensions, etc.) for transmitting motion from the actuator/operator to dampers shall be designed as to functionally operate a load equal to or in excess of 300% of the maximum required operating force for the damper.

3. Crank arms and connecting rods shall be adjustable. Linkages shall be brass, bronze, zinc-coated steel, or stainless steel.

4. Adjustments of crank arms shall control the position of the damper.

5. Use of Operating Linkages external to damper drive shaft shall neither delay nor impede operation of the damper in a manner of performance less than a direct-coupled damper actuator. Operating linkages shall not under any circumstances be permitted to flex, warp, shift etc. under normal operation of connected damper sections.

2.17 AUTOMATIC CONTROL VALVES

A. Automatic Control Valves. Control valves shall be two-way or three-way type for two-position or modulating service as required and/or scheduled. Unless otherwise indicated, all valves shall have a minimum range-ability of 50:1.

B. Body & Trim. Body and trim style and materials shall be in accordance with the manufacturer's recommendations for design conditions and service shown in compliance with the following at a minimum:

1. Equal percentage ports for modulating service.

2. Valve bodies shall meet or exceed pressure and temperature class rating based upon design operating temperature and 150% design operating pressure. Unless otherwise specified or scheduled, minimum body rating for any valve is 125 psi and a maximum fluid temperature of 177˚C (350˚F).

3. Valves shall have stainless-steel stems and packing boxes with extended necks to clear the piping insulation.

4. Globe valves shall have replaceable seats.

C. Close-Off/Differential Pressure Rating. All valves shall be guaranteed to have not more than 1% leakage of design flow rate at the pump shut-off pressure. All valve actuators and trim shall be furnished to provide the following minimum close-off pressure ratings unless otherwise specified or scheduled:

1. Two-way water valves: 150% of total system (pump) head.

2. Three-way water valves: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head (whichever is greater).

3. Steam valves: 150% of operating (inlet) pressure.

D. Water Valves. Unless otherwise specified or scheduled, water valves shall follow the following criteria:

1. Two-position service: Line size.

2. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through the heat exchanger (coil, load, etc.), 50% of the pressure difference between the supply and return mains, or 35 kPa (5 psi) (whichever is greater).

3. Three-way modulating service: Pressure drop shall be equal to twice the pressure drop through the heat exchanger (coil, load, etc.), 35 kPa (5 psi) maximum.

4. Valves 15 mm (1/2”) through 50 mm (2”) shall be bronze or cast brass body ANSI Class 250, spring-loaded, PTFE packing quick opening for two-position service.

5. Valves larger than 80 mm (2 ½”) and shall be cast iron ANSI Class 125 with guided plug and PTFE packing.

6. Valves 15 mm (1/2”) through 50 mm (2”) shall be ANSI/ASME B1.20.1 (NPT) threaded connections.

7. Valves 65 mm (2 ½”) to 80 mm (3”) shall use flanged connections.

E. Control Ball Valves. Where scheduled, control ball valves shall comply with the following:

1. All control ball valves shall be furnished with chrome plated bronze ball and stainless steel stem with fiberglass reinforced Teflon® seats and seals. The valves shall have a blowout proof stem design.

2. The stem packing shall be 2 O-rings designed for modulating service and requiring no maintenance.

3. All control ball valves shall feature characterized flow guides when used for modulating applications.

F. Butterfly Valves: Where scheduled, butterfly valves shall comply with the following:

1. Unless otherwise scheduled, butterfly valves shall have a minimum range ability of 10:1.

2. Bodies for 80 mm (3") to 300 mm (12") valves shall be fully-lugged cast iron. Bodies for larger valves shall be as scheduled.

3. Flanges shall meet the requirements of ANSI Standard 125 and ANSI Standard 150.

4. The stem shall be one-piece, stainless steel and designed as to accommodate 50 mm (2") of insulation.

5. The shaft shall be 316 stainless steel and supported at a minimum of three (3) locations with PTFE bushings for positive alignment.

6. The seat shall be EPDM; phenolic backed, non-collapsible and easily replaceable.

7. The disc shall be aluminum bronze to provide bubble-tight close-off in either direction.

G. Chilled Water Valves. Unless otherwise scheduled or required by the manufacturer valves for chilled water and/or glycol service shall adhere to the following:

1. All internal trim regardless of body style shall be Type 316 stainless steel.

2. Valves larger than 80 mm (3") shall use butterfly valves

2.18 AUTOMATIC CONTROL ACTUATORS

A. Electric Actuation. Unless otherwise specified or scheduled, all control actuators shall be electric/electronic direct-coupled type. Actuators shall have a means for reversing drive direction and a manual override.

1. The actuator shall have electronic overload or stall protection to prevent damage to the actuator throughout rotation. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

B. Sound level shall not exceed 45 dB for high torque nor 35 dB for VAV actuators.

C. Spring Return. Where shown, for power-failure or safety applications, an internal mechanical spring-return mechanism shall be built-in to the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.

1. All mechanical equipment with direct introduction of outside air shall require fail-safe spring return actuators.

2. Terminal equipment without direct introduction of outside air are permitted to have actuators that maintain their last commanded position when power is lost to the actuator.

D. Clutch/Gear Release. All non-spring return actuators shall have an external manual clutch/gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 7 Nm (60 in-LB) torque capacity shall have a manual crank for this purpose.

E. Modulating Actuators. Unless otherwise specified or scheduled, all modulating actuators shall be positive positioning and accept a 0 to 10 VDC or 0 to 20 mA control signal and provide an operating range of 2-10 VDC or 4-20 mA.

F. Position Feedback. All actuators shall feature a visual position feedback indicator. All non-terminal unit actuators shall provide a VDC or mA feedback signal proportional to actuator position.

G. Power. All 24 VAC/VDC actuators shall operate in Class 2 circuits.

H. Enclosure. Actuator casing and/or enclosures shall be appropriate to the application.

1. Actuators used in or near outdoor air streams shall have NEMA 2 (IEC IP21) housings.

2. Actuators exposed to moisture, in wet mechanical rooms or located outdoors shall be meet NEMA 4X (IEC IP66) requirements or as directed by the AHJ.

2.19 TEMPERATURE DEVICES

A. Analog Temperature Sensors. Analog temperature sensors shall be precision element thermistor type.

B. Duct Sensors. Duct temperature sensors shall include junction box for wiring connections and gasket to prevent air leakage and vibration noise.

1. Single point duct temperature sensor probe shall consist of 316 stainless steel extending to the center of the duct.

2. Averaging duct temperature sensor for outdoor air mixing sections shall consist of a Teflon coated, copper, or stainless steel series/parallel averaging sensor element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Averaging sensors shall be a minimum of 1.5 m (5’) in length per 1 m2 (10 ft2) of duct cross sectional area.

C. Immersion Sensors. Liquid immersion temperature sensor shall be provided with a separable stainless steel well, sensor and connection head for wiring connections. The well must be designed to be consistent and appropriate with the system operating pressure and velocity.

D. Space Sensors. Space temperature sensor shall consist of an element within a ventilated cover aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space. These space sensors shall only be used as indicated in public spaces without full-time or full-time-equivalent occupants including but not limited to lobbies, hallways, atriums, break rooms, cafeterias, restrooms, theaters, gymnasiums, mechanical spaces, plenums, etc. These sensors shall consist of a simple temperature sensor compatible with the controller(s), without set-point or bypass. All other spaces shall be controlled via a communicating thermostat as described elsewhere.

E. Outdoor Air Temperature. Outdoor air temperature sensor shall consist of a single device sensor, ventilated non-metallic sun shield, utility box for terminations, and watertight gasket to prevent water seepage.

F. Differential Temperature. Provide matched sensors for differential temperature applications.

G. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL-Listed, vapor pressure type, with an element of 6 m (20') minimum length.

1. Provide one (1) low-limit thermostat for each 2 m2 (20 ft2) of coil face. Low-limit thermostat shall be installed such that for every ft2 of coil face shall be covered by at least 12" of low-limit thermostat element.

2. Low-limit thermostat shall respond to the lowest temperature sensed in by any 30 cm (12") section of the element.

3. Low-limit thermostats shall be manual-reset, DPDT-style with a minimum of one (1) normally-open contact and one (1) normally-closed contact.

H. High-Limit Thermostats. High-limit airstream thermostats shall be UL-Listed, bimetal-operated, manual reset type.

I. Low-voltage Thermostats. Low-voltage thermostats shall be 24 VAC, bimetal-operated or electronic type with adjustable of fixed anticipation heater, concealed set-point adjustment 13˚C to 30˚C (55˚F to 85˚F) set-point range, 1˚C (2˚F) maximum differential and vented ABS plastic housing.

J. Line-voltage Thermostat. Line-voltage thermostats shall be UL-Listed bi-metal actuated, open contact type, enclosed, snap-switch type or equivalent solid-state type with adjustable of fixed anticipation heater, concealed set-point adjustment 13˚C to 30˚C (55˚F to 85˚F) set-point range, 1˚C (2˚F) maximum differential and vented ABS plastic housing.

K. Thermostat guards shall be provided where specified, indicated on control diagram, or indicated on floor plans. Guards shall be firmly attached to wall and thermostat cover shall be visible through guard. Covers shall be clear Lexan. Opaque covers shall be provided where specified.

L. Sensor accuracy and repeatability shall be as described in Table 1 and Table 2 in Part 1 GENERAL, 1.07 SYSTEM PERFORMANCE, paragraph K.

2.20 CARBON MONOXIDE (CO) SENSORS

A. Carbon monoxide (CO) sensors shall have a linear voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output.

B. Carbon monoxide (CO) sensors shall be totally sealed, electro-chemical sensor with audible and visual alarms, adjustable set-point, audible alarm reset, remote alarm and warning relays, tamper resistant case. Warning and alarm level set-points shall be set as recommended by the manufacturer.

1. Output ranges shall be selectable between 0-200 ppm and 0-1000ppm.

2. Alarm relay setting selectable at 100 ppm or 0-1000ppm.

3. Audible exposure alarm 85 dB Piezo transducer.

4. Response time shall be less than 15 seconds.

5. Sensor shall be a UL2034 Recognized Component.

6. Drift shall be less than +/- 5% per year.

7. Ambient operating conditions shall be 0 – 100 ºF; 15 – 95 %RH.

C. Sensor accuracy and repeatability shall be as described in Table 1 and Table 2 in Part 1 GENERAL, 1.07 SYSTEM PERFORMANCE, paragraph K.

D. Provide a gas calibrator kit complete with two cylinders of calibration gas, gas delivery system, flow regulation system, flow meter, pressure gauge, and connector hose. Cylinders with gas should be prepared and labeled in accordance with Federal (DOT) Regulation 39.

2.21 CARBON DIOXIDE (CO2) SENSORS

A. Carbon dioxide (CO2) sensors shall have a linear voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output.

1. Output ranges shall be selectable between 0-2000 ppm and 0-5000ppm.

2. Response time shall be 60 seconds to 90% of reading or better..

3. Sensor shall be a UL2034 Recognized Component.

4. Drift shall be less than +/- 5% per year.

5. Ambient operating conditions shall be 0 – 100 ºF; 15 – 95 %RH.

B. Carbon dioxide (CO2) sensors shall be Non-dispersive Infrared (NDIR) type with relay output.

C. Room carbon dioxide (CO2) sensors shall be enclosed in an ABS plastic case esthetically compatible with space finishes.

D. Duct carbon dioxide (CO2) sensors shall be enclosed in an ABS polycarbonate case suitable for duct mounting.

2.22 HUMIDITY DEVICES

A. Humidity transducers shall have a linear voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output with field adjustable zero and span.

B. Duct Sensors. Duct-mounted humidity sensors shall have a sensing range of 20% to 80% RH and shall be provided with a sampling chamber.

C. Space Sensors. Space sensors shall have a sensing range of 20% to 90% RH.

D. Outdoor Air Sensors. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH and shall be suitable for ambient conditions of -40˚C to 75˚C (-40˚F to 170˚F).

E. Drift. Sensor drift shall not exceed 1% of full scale per year.

F. Humidistats

1. Humidistats shall have SPST snap-acting contacts. The humidistat shall have an adjustable minimum differential of 4 %RH. Contacts shall open on rise in sensed humidity and close on a drop.

G. High Limit Humidity Controller

1. High Limit Humidity Controller shall be duct mounted with an air sampling tube for sampling humidity within the duct.

2. Set-point range shall be 65% to 95% RH in 5% increments. Operable up to 125 ºF.

2.23 PRESSURE DEVCES

A. Pressure Transducers.

1. Pressure transducers shall have a linear voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output with field adjustable zero and span.

2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

B. Water Pressure Transducers. Water pressure transducers shall utilize MEMS technology with built-in snubbers. Differential water pressure transducers shall not require the five-valve manifold for isolation, bypass and bleed.

1. Water pressure transducers shall have over-range protection of at least 2X the rated pressure.

2. Water pressure transducers shall have switch selectable outputs of 2-wire 4-20mA, 3-wirw 0-5Vdc or 0-10 Vdc.

3. Differential water pressure transducers shall consist of two (2) separate pressure sensors terminated, via factory fabricated cabling, to a separate transmitter with LCD display that displays supply, return and differential pressures.

C. Differential Pressure Switches

1. Switch contacts shall be snap action micro-switch type Form C contact.

2. Assembly shall operate automatically and reset automatically when conditions return to normal. Complete sensor assembly shall be protected against vibration and movement.

3. High pressure cutout switches shall be manual reset devices.

4. Switches shall be vented to withstand a 50% over-pressure without loss of calibration.

D. Flow Proving Switches

1. Flow proving switches provided as a part of this specification shall be differential pressure type UL-Listed , SPDT snap-acting, pilot-duty rated (125 VA minimum), NEMA 2 enclosure, with scale range and differential suitable for intended application or as specified.

2.24 AIRFLOW MONITORING STATIONS(AFMS)

A. General

1. Airflow measurement stations shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.

a. Thermal dispersion devices that indirectly heat a thermistor are not acceptable.

2. Provide one AFMS for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.

3. Substitution requests for acceptance less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.

4. Each AFMS shall be provided with a microprocessor-based transmitter and one or more sensor probes.

a. Devices that have electronic signal processing components on or in the sensor probe are not acceptable.

5. Airflow measurement shall be field configurable to determine the average Actual or Standard mass airflow rate.

a. Actual airflow rate calculations shall have the capability of being corrected by the transmitter for altitudes other than sea level.

6. Temperature measurement shall be field configurable with velocity weighted average as the default, or manual selection of arithmetic average temperature.

B. Sensor Probes

1. Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube, 316 stainless steel tube are available when required.

2. Sensor probe mounting brackets shall be constructed of 304 stainless steel.

3. Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper.

   a. PVC jacketed internal wiring is not acceptable.

4. Probe internal wiring connections shall consist of solder joints and spot welds.

   a. Internal wiring connections shall be sealed and protected from the elements. They shall be capable of direct exposure to water without affecting instrument operation.

   b. Connectors of any type within the probe are not acceptable.

   c. Printed circuit boards within the probe are not acceptable.

5. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from -67° F to 392° F (-55° C to 200° C) and continuous and direct UV exposure.

   a. Plenum rated PVC jacket cables are not acceptable.

6. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.

7. Each sensor probe shall contain one or more independently wired sensing nodes.

8. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter in the field.

9. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Upon request, the manufacture shall provide a written independent laboratory test result of 100% survival rate in a 30 day saltwater and acid vapor test.

   a. Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.

   b. Devices with exposed leads are not acceptable.

10. Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.

11. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of ±2% of reading over the entire calibrated airflow range of 0 to 5,000 FPM (25.4 m/s).

    a. Upon request the manufacture shall submit for AMD approval a copy of the NIST report of calibration used for the reference standard used.

        1) Devices claiming NIST traceability to third party laboratories and not directly to NIST are not acceptable

        2) Devices calibrated against standards other than the NIST LDA are not acceptable.

12. The number of independent sensor nodes provided shall be as per the manufacturers recommendation.

C. Transmitter

1. A remotely located microprocessor-based transmitter shall be provided for each measurement location.

2. The transmitter shall be comprised of a main circuit board and interchangeable interface card.

3. All printed circuit board interconnects, edge fingers, receptacle plug pins and PCB test points shall be gold plated.

4. All printed circuit boards shall be electrolysis nickel immersion gold (ENIG) plated.

5. All integrated circuitry shall be temperature rated as ‘industrial-grade’. Submissions containing ‘commercial-grade’ integrated circuitry are not acceptable.

6. The transmitter shall be capable of determining the airflow rate and temperature average of all connected sensor nodes in an array for a single location.

    a. Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).

7. The transmitter shall be capable of providing a high and/or low airflow alarm with user-defined set point and % of set point tolerance. Alarm shall be capable of being manually or automatically reset and low-limit cutoff value may be selected to disable the alarm. An alarm delay function shall also be field defined.

8. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.

9. The transmitter shall be capable of field configuration, diagnostics and include Field Output Adjustment Wizard that allows for a one or two point field adjustment to factory calibration for installations that require adjustment.

10. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.

11. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals (AO1=airflow, AO2=temperature or alarm), in combination with [select one of the following]

    a. one isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection, or

    b. one isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection.

12. The analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate and the second output (AO2) shall be field configurable to provide one of the following:

    a. temperature

    b. low and/or high airflow user-defined set point alarm, or

    c. system status alarm

13. The transmitter shall also be available with a single isolated LonWorks Free Topology network interface. Transmitters shall be available alternatively with one USB connection for thumb-drive data logging of sensor data. Neither of these options shall include analog output signals.

14. The network communications RS-485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, hi and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures. Individual node airflow rates and temperatures shall NOT be available via the network with Lon.

15. The transmitter shall have an on-off power switch. Isolation transformers shall not be required.

16. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @20 V-A maximum and use a switching power supply that is over-current and over-voltage protected.

17. The transmitter shall use a “watchdog” timer circuit to ensure automatic reset after power disruption, transients and brown-outs.

18. Each transmitter shall have an operating temperature range of -20° F to 120° F (-28.9° C to 48.9° C) and humidity range of 5 to 95% RH.

19. All network-capable AMD models supplied with RS-485 interface and BACnet protocol shall be BTL Listed.

2.25 CURRENT DEVICES

A. AC Current Transmitters. AC current transmitters shall be UL-Listed self-powered, combination split-core current transformer type with two-wire voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output.

1. Ranges shall include 10, 20, 50, 100, 150 and 200 Amp full-scale with internal zero and span adjustment and ±1% full-scale accuracy at 500 ohm maximum burden.

2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA certified.

B. Current Transformers. Current transformers shall be UL/CSA recognized, split-core and completely encased (except for terminals) in approved plastic material. Transformers shall be selected for ±1% accuracy at 5 A full-scale output.

C. Current Switches shall be UL-Listed self-powered, split-core or solid core type with fixed trip current, status LED and solid state contact output.

2.26 VOLTAGE DEVICES

A. Voltage Transmitters.

1. AC voltage transmitters shall be UL-Listed self-powered two-wire type with voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output and with zero and span adjustment.

2. Ranges shall include 100-300 VAC, 200-250 VAC, 250-330 VAC and 400-600 VAC full-scale, adjustable with ±1% full-scale accuracy with 500 ohm maximum burden.

3. Transmitters shall be UL/CSA recognized at 600 VAC rating and meet or exceed the requirements of ANSI/ISA S50.1.

B. Voltage Transformers.

1. AC voltage transformers shall be UL/CSA recognized at 600 VAC rated, complete with built-in fuse protection and completely encased (except for terminals) in approved plastic material.

2. Transformers shall be suitable for 4˚C to 45˚C (40˚F to 130˚F) and shall provide ±0.5% full-scale accuracy at 24 VAC and a 5 VA load.

2.27 THERMAL ENERGY METERS

A. Not provided under this project’s scope.

2.28 ELECTRICAL ENERGY METERS

A. Not provided under this project’s scope.

2.29 RELAYS

A. Control relays shall be UL-Listed, enclosed with LED energized indicator. Contact rating, configuration and coil voltage shall be suitable for application. Coil current shall be less than 50 mA.

2.30 TEMPERATURE CONTROL PANELS

A. Temperature Control Panels. Provide pedestal base or wall mounted local control enclosures to be fully enclosed NEMA 1 (IEC IP20) at a minimum with hinged door, key-lock latch and removable subpanels to house all control components appropriate to the environment, service, and/or as required by the code enforcing authorities and other AHJ.

1. All enclosures shall be UL-Listed.

2. Enclosures in mechanical rooms shall meet NEMA 2 (IEC IP21) requirements at a minimum or as directed by the AHJ.

3. Enclosures in all locations not requiring NEMA 2 (IEC IP21) including occupied spaces, above ceilings and plenums shall be the same NEMA (IEC) classification as other enclosures located in the same environment, except if location requires additional protection due to potential vandalism or environmental conditions or as directed by the AHJ.

4. Enclosures exposed to moisture, in wet mechanical rooms or located outdoors shall be meet NEMA 4X (IEC IP66) requirements or as directed by the AHJ.

5. Unless otherwise required by local codes and/or AHJ, all enclosures shall be a minimum of 16-gauge steel or aluminum, totally enclosed on all sides and powder coated or painted with a baked enamel finish.

2.31 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies & Control Transformers. Control transformers and power supplies shall be UL-Listed. Provide Class 2 current-limiting type or over-current protection in both primary and secondary circuits for Class 2 service not to exceed 100 VA in accordance with the applicable following requirements or as directed by the AHJ.

1. NEC 2011 (NFPA 70) Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits.

2. NEC 2011 (NFPA 70) Chapter 9 Table 11(A) and Table 11(B).

3. Canadian Electrical Code, Part 1 (CSA C22.1-12) Rule 16-200.

B. DC Power Supplies. DC power supply output shall match output current and voltage requirements. Power supply shall be half-wave rectified type with the following minimum specifications:

1. Output ripple: 5.0 mV maximum peak-to-peak.

2. Regulation: 1.0% line and load combined.

3. Response: 100 ms for 50% load changes.

4. Built-in overvoltage and overcurrent protection and able to withstand a 150% current overload for a minimum of three (3) seconds without tripping or failure.

C. Power Line Filtering. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component.

2.32 INTERCONNECTING WIRING AND RACEWAYS

A. Wiring & Cable. All wiring regardless of service and/or voltage shall comply with the Contract Document Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ).

B. All insulated wire to be copper conductors, UL labeled for 90 ˚C minimum service.

END OF PART 2

PART 3 - EXECUTION

3.01 GENERAL PROJECT REQUIREMENTS

A. The System, all its components, execution, and compliance with this specification is the responsibility of the Building Automation System (BAS) Contractor.

1. Unless specified otherwise, all System devices and components as required to appropriately satisfy the intent of the specified Sequence of Operations, the requirements of the contract drawings and of this specification shall be provided as a part of this section.

2. All control system components shall be installed in locations as required to properly sense the controlled medium and perform per the intent of the specified Sequence of Operations, the requirements of the contract drawings and of this specification.

B. Statement of Compliance. The System Contractor must submit a Statement of Compliance to the Owner, Owner's Agent, and/or Contract Officer that details compliance with the specification requirements in a spreadsheet format.

1. The Statement of Compliance must be received by the Owner, Owner's Agent, and/or Contract Officer a minimum of fourteen (14) days prior to the bid/tender date; and must be received prior to submitting any proposals or pricing.

2. The Statement of Compliance must detail each DDC component including at a minimum all controllers, communicating sensors, network components, software, server and workstation hardware, as well as any other components to be provided as a part of this specification as directed by the Owner, Owner's Agent, Contract Officer, and/or Engineer.

3. For each DDC component, the individual model/type and version to be provided under this specification must be represented in the Statement of Compliance complete with Specification clause, Tag, Manufacturer, Make, Model, Version, and Quantity.

4. For any DDC component that complies with all specification requirements, a single line may be entered in the Statement of Compliance indicating simply "Complies with all requirements as specified". If all DDC components comply with all specification requirements, a signed statement on company letterhead may be submitted indicating that "All components comply with all requirements as specified".

5. For any component that does not comply with all specification requirements, each specification clause applicable to the component must be listed in the Statement of Compliance and for each clause the contractor must indicate either "Comply" or "Does Not Comply".

6. If, after having submitted a Statement of Compliance indicating that a DDC component is in-compliance with the requirements of the specification, the component is found to be non-compliant, it shall be the responsibility of the Contractor to replace the component at no additional charge with a compliant component at the discretion of the Owner, Owner's Agent, Contract Officer, and/or Engineer.

7. If a DDC component is omitted from the Statement of Compliance and is found to be non-compliant, it shall be the responsibility of the Contractor to replace the component at no additional charge with a compliant component at the discretion of the Owner, Owner's Agent, Contract Officer, and/or Engineer.

8. If a Statement of Compliance is not submitted, it shall be the responsibility of the Contractor to replace any non-compliant component at no additional charge with a compliant component at the discretion of the Owner, Owner's Agent, Contract Officer, and/or Engineer.

C. Ownership. All hardware, databases, programming, and data provided by and/or resultant from the System provided under this specification shall become the exclusive property of the Owner.

D. BACnet Virtual Private Network (B/VPN). All BACnet internetwork communication between separate broadcast domains shall be required to be secured using a BACnet Virtual Private Network (B/VPN).

E. Workstation. Provide one (1) BACnet Advanced Operator Workstation or one (1) Embedded Operator Workstation as outlined in this specification and as directed by the Owner.

F. HVAC Graphical Component Library. A library of standard HVAC graphical image components consistent with the delivered graphical user interface shall be provided.

1. The library of standard HVAC graphical image components shall allow the Owner to create custom graphics consistent with the delivered graphical user interface using standard image file formats and the drawing or graphical development application of choice.

   a. The library of standard HVAC graphical image components provided to the Owner shall not require the use of any proprietary or specific graphics development application.

2. The library of standard HVAC graphical image components provided shall include all the equipment and standard symbols used in the graphical user interface delivered as a part of the System.

3. The library must include professionally rendered three-dimensional (3D) static and animated images.

   a. The library shall be provided complete with representations of mechanical equipment (e.g., AHUs, chillers, boilers, etc.), mechanical components (e.g., pumps, fans, coils, compressors, dampers, sensors, etc.) and interconnecting ductwork, piping, etc.

   b. All graphical image components provided shall be available at the same perspective allowing for individual components to interlock for the construction of custom equipment, systems and piping schemes.

c. The library shall be provided to include isometric piping components in colors compliant with the ANSI/ASME A13.1 standard for pipe and valve marking for the construction of custom piping systems consistent with the physical orientation and configuration.

4. For the duration of the warranty period, the System Contractor shall make available to the Owner, upon request, custom components not included in the library of standard HVAC graphical components as required to represent equipment included in this Contract.

a. Giving the Owner access to a graphical image library or service that develops custom components on request is an acceptable alternative to Contractor-developed components.

G. Mobile connectivity. The System shall be capable of being accessed via a mobile browser or a mobile app for an untethered mobile operator interface.

H. Archive Server. Provide BACnet Data Archive Server with sufficient capacity for archival of critical system-level objects at 96 samples per day for the duration of the warranty period.

I. Server/Hardware Platform. Provide one (1) hardware platform as required to satisfy the requirements for the provided workstation, the Archive Server and this specification.

J. Terminal Unit Space Sensors. Provide one (1) communicating space sensor with temperature, set-point, occupancy bypass, keypad and digital display for each terminal unit.

K. SNTP Time Synchronization. The system time of all BACnet devices on the internetwork must be automatically synchronized using SNTP.

1. The System shall be automatically synchronized with a Simple Network Time Protocol (SNTP) server (e.g., us.pool.ntp.org, ca.pool.ntp.org, etc.).

2. The System shall automatically synchronize controller clocks from a designated Time Master at a minimum of once per hour via the internetwork.

L. Training. Provide twelve (6) days of on-site training for personnel designated by the Owner and a representative of the Master Systems Integrator as detailed below:

1. Provide four (2) days of on-site or classroom training sessions throughout the contract period.

2. Provide five (3) days of training immediately following demonstration and acceptance.

3. Provide one (1) day of training each at 3-, 6- and 12-months following demonstration and acceptance.

3.02 COORDINATION

A. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades and equipment manufacturers to ensure a fully functioning and complete BAS.

B. All automatic control dampers, control valves, separable sockets, flow switches, flow sensors, and other in line pipe devices, furnished by the BAS Contractor shall be installed by the HVAC Contractor under the BAS Contractor's supervision. All blank off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the HVAC Contractor.

C. The demarcation of work and responsibilities between the BAS Contractor and other related trades shall be as outlined in the Responsibility Matrix herein. This matrix is not intended to relieve the BAS Contractor of the obligation to assure the complete execution of any work for which responsibility is assigned to the BAS Contractor, when the BAS Contractor is a sub-contractor to the HVAC Contractor.

D. The matrix key is as follows:

1. BAS Building Automation System Contractor
2. MSI Master Systems Integrator
3. P Plumbing Contractor
4. H HVAC Contractor
5. E Electrical Contractor
6. EX Existing reuse
7. EP Power for the device controls is provided by means internal to the device. Control power is provided from the power circuit to the device, which is the responsibility of the Electrical Contractor.
8. Wiring Note: Power wiring by "BAS" indicates that the BAS Contractor is responsible for extending power from a junction box or source, which has been provided by the Electrical Contractor, to a device or through a transformer to low voltage system. Transformer is to be provided by the BAS Contractor.

RESPONSIBILITY MATRIX

	WORK	Furnished By:	Installed By:	Low Voltage Wiring By:	Power Wiring By:
1.	VAV Box Controllers and Terminal Unit Controllers	BAS	BAS	BAS	E
2.	Automatic Control Dampers and Actuators	BAS	H	BAS	BAS
3.	Manual Valves	H	H	N/A	N/A
4.	Automatic Valves and Actuators	BAS	H	BAS	BAS
5.	VAV Boxes	H	H	N/A	N/A
~~5a.~~	~~Fan-Powered VAV Boxes~~	~~H~~	~~H~~	~~N/A~~	~~E~~

RESPONSIBILITY MATRIX

	WORK	Furnished By:	Installed By:	Low Voltage Wiring By:	Power Wiring By:
6.	Pipe Insertion Devices and Taps including thermos-wells, flow and pressure stations, etc.	BAS	H	BAS	N/A
7.	Current Switches	BAS	BAS	BAS	N/A
~~8.~~	~~Electrical Energy Meters~~	~~BAS~~	~~E~~	~~BAS~~	~~EP~~
~~9.~~	~~Control Air Compressors~~	~~H~~	~~H~~	~~N/A~~	~~E~~
~~9a.~~	~~Air Compressor Dryer~~	~~H~~	~~H~~	~~N/A~~	~~E~~
~~9b.~~	~~Air Compressor Tank Drain~~	~~H~~	~~H~~	~~N/A~~	~~E~~
10.	BAS interface with Chiller Control Package	H	H	BAS	E
11.	Chiller Controls Interface to BAS	H	H	BAS	EP
12.	Chiller and Boiler Flow Switches	H	H	BAS	N/A
13.	Boiler Control Package	H	H	BAS	E
14.	Water Treatment System	H	H	H	E
15.	Variable Frequency Drives	BAS	E	BAS	E
16.	Refrigerant Monitors	H	BAS	BAS	E
~~17.~~	~~Computer Room A/C Unit Site-Mounted Controls~~	~~H~~	~~BAS~~	~~BAS~~	~~EP~~
22.	Fan Coil Unit Controls	BAS	BAS	BAS	EP
23.	Unit Heater Controls	H	H	N/A	E
~~24.~~	~~Packaged Rooftop Unit (RTU) Space Mounted Controls~~	~~H~~	~~BAS~~	~~BAS~~	~~EP~~
~~25.~~	~~Packaged RTU Factory-Mounted Controls~~	~~H~~	~~H~~	~~EP~~	~~EP~~
~~26.~~	~~Packaged RTU Field-Mounted Controls~~	~~H~~	~~BAS~~	~~BAS~~	~~EP~~
~~27.~~	~~Cooling Tower Vibration Switches~~	~~H~~	~~H~~	~~EP~~	~~EP~~
~~28.~~	~~Cooling Tower Level Control Devices~~	~~H~~	~~H~~	~~E~~	~~E~~
~~29.~~	~~Cooling Tower Makeup Water Control Devices~~	~~H~~	~~H~~	~~E~~	~~E~~
~~30.~~	~~Pool Dehumidification Unit Controls~~	~~H~~	~~BAS~~	~~BAS~~	~~EP~~
~~31.~~	~~Tenant Meters~~	~~BAS~~	~~E~~	~~BAS~~	~~EP~~
32.	LV Lighting Control Relays And Switches	E	E	E	E
33.	Addressable Lighting Control Modules And Panels	E	E	E	E
34.	Photo and Occupancy Sensors	E	E	E	E
35.	Operable Lighting Breaker Panels	E	E	E	E
36.	Area Smoke Detectors	E	E	E	E
37.	Duct Smoke Detectors	E	H	BAS/E	EP
38.	Fire Alarm Wiring from all Detectors	E	E	E	E
39.	Wiring from Smoke Detector/Fire Alarm to Control LED Devices and/or Smoke Damper Actuators	E	E	E	E
40.	Smoke Damper and Actuators	H	E,H	E	E
41.	Exterior Lighting Contactor	E	E	E	E
43.	Exterior Lighting Controller	E	E	E	E
44.	Domestic Recirculating Pump	H	H	BAS,E	E

E. Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the Building Automation System (BAS) Contractor shall assist in coordinating space requirements.

F. Coordinate and schedule work with all other trades in the same area, or with work that is dependent upon other trades to facilitate mutual progress. Report all conflicts and anticipated delays to the project construction management team for resolution immediately upon identification.

G. Life Safety.

1. Duct smoke detectors required for air handling unit shut down are furnished under another division of this specification. The Building Automation System (BAS) Contractor shall interlock smoke detectors to air handling units for shut down as described in the Sequences of Operation.

2. Smoke dampers and actuators required for duct smoke isolation are provided under another division of this specification. The Building Automation System (BAS) Contractor shall interlock smoke detectors to air handling units if required and as described in the Sequences of Operations.

H. Other sections and/or divisions of this specification include controls and control devices that are to be a part of or interfaced to the Building Automation System (BAS) specified in this section. These devices shall be integrated into the Building Automation System (BAS) and coordinated by the Building Automation System (BAS) Contractor as follows:

1. All communication and network media and equipment integrated with the Building Automation System (BAS) provided by any Contractor or Vendor shall comply with the requirements of this specification.

2. The Contractor/Supplier furnishing and/or providing any controls products to be integrated to the Building Automation System (BAS) are responsible for the configuration, programming, start-up, testing, and proof-of-performance of that product to meet the requirements of the Sequences of Operation.

3. The Building Automation System (BAS) Contractor shall coordinate resolution of incompatibilities that arise between the control products provided as a part of this section and products provided as a part of other sections or divisions of the specification.

3.03 GENERAL WORKMANSHIP

A. Building Automation System (BAS) installation shall be performed by professionals in a workmanlike manner consistent with acceptable industry standards for performance and in compliance with the contract documents, Project Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ) and in compliance with the following at a minimum:

1. Installation of all DDC devices, enclosures, wiring, equipment, control devices and sensors shall be installed in accordance with the manufacturers' recommended installation procedures and as specified.

2. All control devices are to be provided and installed with all required gaskets, seals, flanges, connection enclosures, thermal compounds, insulation, piping, fittings and valves as required for design operation, isolation, equalization, purging and calibration.

3. Install all equipment as to be readily accessible as defined by Chapter 1, Article 100, Part A of the National Electric Code (NEC) or CSA C22.1-12 Rule 2 (as applicable) and/or local codes and standards whichever is more stringent and such that it provides sufficient clearance for system maintenance, component service, calibration, removal, repair or replacement.

4. Install all equipment, piping, and wiring/raceway parallel to building lines.

5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

6. All control devices mounted outdoors shall be protected by a weather-shield, integral outdoor enclosure, etc. and from ambient elements in such a manner as to not impede design functionality and/or sensing.

7. Dielectric isolation shall be provided where dissimilar metals are used in installation for connection and support.

8. Penetrations through and mounting holes in the building exterior associated with the Building Automation System (BAS) installation shall be sealed and made water-tight.

3.04 FIELD QUALITY CONTROL

A. Building Automation System (BAS) Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

B. Building Automation System (BAS) Contractor shall have all work inspected as required by local and/or regional code enforcing authorities and/or AHJ.

3.05 BUILDING AUTOMATION SYSTEM (BAS) ARCHITECTURE

A. A Protocol Implementation Conformance Statement (PICS) including a BACnet® Interoperability Building Block (BIBB) table shall be provided for each DDC device (hardware and software) provided under this specification.

B. No single MS/TP (Master-Slave/Token-Passing) segment shall exceed 32 full-load nodes.

C. No single MS/TP segment shall exceed 32 devices that do not support Read Property Multiple (RPM) and Segmentation for both Transmit and Receive. For the purposes of this specification, devices that do not support both shall be considered full-load nodes.

D. The Building Automation System (BAS) as provided and installed under this specification shall implement the following BACnet® data links only:

1. Point-to-Point (PTP).

2. Master-Slave/Token-Passing (MS/TP).

3. Ethernet (ISO 8802.3).

4. IP (B/IP).

5. All other BACnet® data links shall be excluded from this project.

E. Each mechanical system and/or piece of mechanical equipment shall be controlled by one (1) dedicated DDC device with sufficient hardware and software capabilities that it shall be connected to all field devices associated with the mechanical system and/or piece of mechanical equipment. Distributed control of one (1) mechanical system and/or piece of mechanical equipment by multiple controllers shall be strictly prohibited.

F. Where any licensing is required, the system shall be delivered with sufficient licensing for 100% expansion of objects, networks, devices and operator workstations for a minimum of five (5) years from the acceptance date as a part of this contract.

G. The Building Automation System (BAS) shall support the ability for a common BACnet® Broadcast Management Device (BBMD) Broadcast Distribution Table (BDT) to be configured once and then broadcasted to all BBMDs provided as a part of this contract. Where the BDT must be manually and/or individually configured, the system contractor shall be responsible for maintenance and configuration of all system BDTs for the duration of the warranty period.

3.06 QUALITY ASSURANCE

A. Upon request the Building Automation System (BAS) Manufacturer shall provide documentation supporting certified compliance with ISO 9001:2008 containing the ISO 9001:2008 Certification Mark from an applicable registrar.

B. The Building Automation System (BAS) Contractor shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship provided under this specification section.

C. Upon request, the Building Automation System (BAS) Contractor shall present the following:

1. Certification of technical training from the Building Automation System (BAS) Manufacturer including hours of instruction and course outline for each installer, technician and application engineer that will be involved on this project.

2. Resumes for each installer, technician, application engineer and project manager that will be involved on this project.

3. References from previous projects of comparable scope, type and service specified.

4. All qualifications shall be provided within seven (7) calendar days of initial request.

D. The Building Automation System (BAS) Contractor shall maintain a comprehensive service office within 160 miles (260 km) of the project location by the bid date and at a minimum until the completion of the warranty period.

1. Comprehensive service office shall be defined as a full-time operational center where Building Automation System (BAS) professionals are regularly employed performing at a minimum the responsibilities and services of installation, design, application engineering, service and project management of complete Building Automation System (BAS)s consistent in scope, type and service specified.

3.07 WARRANTY

A. A.The Building Automation System (BAS) Manufacturer shall provide a warranty certificate covering all DDC devices for a period of at least five (5) years.

3.08 BACNET® ADVANCED OPERATOR WORKSTATION PLATFORM

A. BACnet® Advanced Operator Workstation provided shall comply with all relevant sections of this specification

B. BACnet® Advanced Operator Workstation hardware platform shall comply with the following at a minimum:

1. Processor: Intel Core i3 (3 GHz).

2. Memory: 4 GB RAM.

3. Hard Drive: 500 GB 7200 RPM SATA.

4. Optical Drive: CD-ROM 16x.

5. Video: XGA.

6. Keyboard: Enhanced style keyboard with 101 key layout, 10 function keys, numeric keypad and separate cursor control pads.

7. Mouse: Two button with adjustable sensitivity.

8. Ports:

a. Minimum one (1) NIC.

b. Minimum four (4) USB 2.0.

9. Microsoft Windows Operating Systems:

a. Windows Server 2008 R2; or Windows Server 2012.

b. Windows 7 64-bit Professional or newer Widows Professional version or Enterprise.

3.09 GRAPHICAL USER INTERFACE (GUI) HVAC GRAPHICAL IMAGE COMPONENT LIBRARY

A. BACnet® Advanced Operator Workstation shall be provided with a library of standard HVAC graphical image components consistent with the delivered graphical user interface for the use of Owner.

B. The library of standard HVAC graphical image components shall allow the Owner to create custom graphics consistent with the delivered graphical user interface.

C. The library of standard HVAC graphical image components shall include professionally rendered three-dimensional (3D) static and animated images.

1. The library shall be complete with representations of mechanical equipment (e.g., AHUs, chillers, boilers, etc.), mechanical components (e.g., pumps, fans, coils, compressors, dampers, sensors, etc.) and interconnecting ductwork, piping, etc.

2. All graphical image components shall be available at the same perspective allowing for individual components to interlock for the construction of custom equipment, systems and piping schemes.

3. The library shall include isometric piping components in colors compliant with the ANSI/ASME A13.1 standard for pipe and valve marking for the construction of custom piping systems consistent with the physical orientation and configuration.

D. The library of standard HVAC graphical image components shall include all of the equipment and standard symbols used in the delivered graphical user interface.

E. Individual static HVAC graphical image components in the library shall be accessible as one of the following standard image file formats:

1. JPG/JPEG.

2. GIF.

3. BMP.

4. PNG.

F. The library of standard HVAC graphical image components shall allow the Owner to create custom graphics consistent with the delivered graphical user interface using standard image file formats and the drawing or graphical development application of choice.

1. The library of standard HVAC graphical image components shall not require the use of any proprietary or specific graphics development application.

G. For the duration of the warranty period, the Contractor shall make available to the Owner, upon request, custom components not included in the library of standard HVAC graphical image components as required to represent equipment included in this Contract.

1. Giving the Owner access to a graphical image library or service that develops custom components on request is an acceptable alternative to Contractor-developed components.

3.10 EMBEDDED BACNET® OPERATOR WORKSTATION (B-OWS)

A. Embedded BACnet® Operator Workstations provided shall comply with all relevant sections of this specification.

B. Embedded BACnet® Operator Workstations shall comply with all of the Part 2 Product requirements for the BACnet® Building Controller (B-BC).

C. Embedded BACnet® Operator Workstations shall provide native BACnet® communications directly with all devices on the internetwork. Applications that require translation of data, gateways, or mapping of any kind shall not be acceptable.

1. Embedded BACnet® Operator Workstation shall provide BACnet® client and server functionality as delivered under this specification.

D. Embedded BACnet® Operator Workstation shall not require any hardware, software or firmware licensing agreements; or if required, hardware, software or firmware licensing agreements shall not limit functionality, feature-set, database, network, time and operator/users or seats, shall be without expiration and without maintenance charges for the owner.

E. Multiple embedded BACnet® Operator Workstations shall be capable of being deployed on the same BACnet® internetwork as needed for this project and/or future expansion without requiring any additional licensing or the addition of supervisory and/or coordinating hardware or software systems.

1. Browser clients shall have the ability to access any individual embedded BACnet® Operator Workstation on the Internetwork directly.

2. Where additional licensing could otherwise be required or implemented during the warranty period for the addition or expansion of embedded BACnet® Operator Workstations, said licensing or systems must be provided under this specification to accommodate 100% expansion of the system as specified.

F. Functionality of the embedded BACnet® Operator Workstations shall neither be defined nor limited by feature licensing. Limited functionality includes but is not limited to memory, client/server service support, intrinsic communication protocol and/or data link support, archiving support, GUI support, etc.

1. Where functionality could otherwise be restricted by licenses or other software means, the embedded BACnet® Operator Workstations provided under this specification shall be required to have all features intrinsic to the platform licensed and enabled.

G. All embedded BACnet® Operator Workstations provided under this specification shall be required to provide the following simultaneous intrinsic and enabled physical communication networks at a minimum:

1. One (1) ISO 8802-3 Ethernet port @ 100 Mbps.

2. One (1) EIA-232 port @ 115.2 Kbps.

3. Two (2) EIA-485 ports @ 76.8 Kbps.

H. All embedded BACnet® Operator Workstations provided under this specification shall be required to provide the following simultaneous communication protocols and/or data links at a minimum:

1. ANSI/ASHRAE Standard 135: BACnet®.

a. One (1) Point-to-Point (PTP): ANSI/ASHRAE Standard 135.10.

b. One (1) Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.

c. One (1) ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.

d. Two (2) BACnet®/IP: ANSI/ASHRAE Standard 135 Annex J.

2. Modbus.

a. Remote Terminal Unit (RTU) Master or Slave.

b. TCP Master or Slave.

3. Simple Mail Transfer Protocol (SMTP).

a. Transport Layer Security (TLS) for SMTP must be supported including compatibility with standard free email services (e.g., Gmail, Yahoo!, Outlook.com).

b. The ability to manage custom TLS certificates from SMTP must be supported.

c. The ability to transmit a simple test email to verify SMTP configuration with a single operator action (e.g., pressing a Test Email button) must be provided.

4. Simple Network Management Protocol (SNMP).

5. Hypertext Transfer Protocol (HTTP).

I. If any additional hardware including communication cards, ports, licenses or gateways are required to support these networks they must be provided as a part of this contract. Any additional hardware must be warranted by the manufacturer as proven by a certificate from the manufacturer for a period of five (5) years at a minimum.

J. Embedded BACnet® Operator Workstations shall provide graphically-oriented thin-client operator interface.

1. The current versions of the following standard web browsers shall be supported at a minimum:

a. Microsoft Internet Explorer.

b. Google Chrome.

c. Mozilla Firefox.

d. Apple Safari.

2. Custom HTML programming shall not be required to create or display system graphics or data on a web page.

3. A customizable navigation/file tree shall be provided.

4. Individual user home pages as determined by the user credentials shall be supported. Each user's ability to navigate the B-OWS shall be determined by their log-in credentials.

K. Each embedded BACnet® Operator Workstation shall support unlimited access for a minimum of five (5) simultaneous users.

L. Embedded BACnet® Operator Workstations shall provide an Audit Trail feature that automatically records the date, time, user, and action associated with all user access and changes made via web browser clients.

M. Embedded BACnet® Operator Workstations shall store complete help files describing system configuration, and use of the browser interface. The help files shall be served on-line as part of the browser interface.

1. The browser interface shall include tool tips to describe the features and functionality of the interface.

3.11 ENTERPRISE-LEVEL BACNET® OPERATOR WORKSTATION (B-OWS)

A. Not included under this project's scope.

3.12 BACNET® DATA ARCHIVE SERVER

A. The BACnet® data archive server provided shall comply with all relevant sections of this specification.

B. BACnet® Data Archive Server software shall be a BTL-Listed BACnet® device and shall comply with all of the Part 2 Product requirements for the BACnet® Data Archive Server software.

C. The BACnet® data archive server is designed for long-term storage of historical data and does not supersede the requirement for local short-term storage of BACnet® Trend Logs and runtime logs on individual BACnet® control devices.

D. The BACnet® data archive server shall permit viewing of BACnet® Trend Logs and runtime logs within the installed BACnet® web-enabled application software or Operator Workstation Software operator interface using standard visualizations and methods without requiring a separate trend Log viewing application.

E. The BACnet® data archive server shall support connection to multiple BACnet®/IP network segments and BACnet® internetworks with a single installation instance.

F. All data acquired by the BACnet® data archive server shall be automatically stored in a standard SQL database, accessible by third-party SQL applications

G. In addition to the BACnet® data archive server software, the following software shall also be provided and installed on the BACnet® data archive server platform at a minimum:

1. Microsoft SQL Server 2012 R2 Express Edition.

H. The BACnet® data archive server shall automatically acquire configured trend log and runtime log data from the BACnet® internetwork and archive the data at configured intervals without user intervention.

I. The BACnet® data archive server shall support configurable automatic event notification via e-mail in the event of the following failures at a minimum:

1. Communication failures.

2. Corrupt data.

3. Offline devices.

4. SQL database/access errors.

5. Archive service failures.

J. In the event that there should be a temporary SQL database access or read/write error, the BACnet® data archive server shall be capable of building a storage queue of data to be written to the SQL database when it becomes available.

K. The BACnet® data archive server hardware platform shall comply with the following minimum specification requirements:

1. Processor: Intel Core i5 (3 GHz).

2. Memory: 4 GB RAM.

3. Hard Drive: 500 GB 7200 RPM SATA.

4. Optical Drive: CD-ROM 16x.

5. Ports:

a. Minimum one (1) NIC.

b. Minimum four (4) USB 2.0.

6. Microsoft Windows Operating Systems:

a. Windows Server 2012 R2.

b. Windows 7 64-bit Professional; or Windows 8 64-bit Professional or Enterprise.

3.13 CONTOLLERS

A. Provide a separate, dedicated DDC controller for each mechanical system or piece of equipment. Multiple pieces of mechanical equipment comprising one mechanical system may be controlled by a single DDC controller provided that all of the points associated with the equipment are hosted by the controller. Distributed control of one piece of mechanical equipment shall not be performed by multiple DDC controllers.

1. Objects used for trim and respond or demand-based reset control such as outdoor air temperature, space temperatures or terminal loads are not included in this requirement.

B. Building level controllers and field level equipment controllers shall be selected to provide a minimum of 20% spare I/O point capacity for each point type on each controller.

1. Where universal inputs are not provided, 20% spare inputs of each individual type (e.g., analog, binary, etc.) are required.

2. Where universal outputs are not provided, 20% spare outputs of each individual type (e.g., analog, binary, etc.) are required.

C. For unitary and space-mounted controllers, where software-selectable universal inputs are not available, one (1) spare analog input and one (1) spare binary input shall be required on each terminal unit controller after the requirements of the sequence of operation specified in the contract documents have been satisfied.

D. Operator Override. All DDC controllers shall support operator-initiated timed overrides of hardware and software objects with user-configurable override periods. When the override period has expired, the controller shall automatically return the object to the automatic state without any additional action on the part of the Operator.

1. The timed override functionality shall exist entirely in the controller. A workstation shall not be required for the execution of the time period nor for returning the object to automatic.

3.14 BUILDING LEVEL CONTROLLERS

A. The building level controllers provided shall comply with all relevant sections of this specification.

B. Provide one (1) dedicated BACnet® Building Controller (B-BC) for the execution of global strategies and for each large point-count major mechanical system and/or piece of equipment.

1. Any application exceeding eight (8) inputs or eight (8) outputs shall not be considered a terminal unit application and shall require a dedicated field-level equipment controller or a building-level controller.

C. Each building level controller shall be provided with an integral power switch or a dedicated fused transformer and switch inside the enclosure.

D. All building level controllers provided under this specification shall be required to provide the following simultaneous intrinsic and enabled physical communication networks at a minimum:

1. One (1) ISO 8802-3 Ethernet port @ 100 Mbps.

2. One (1) EIA-232 port @ 115.2 Kbps.

3. Two (2) EIA-485 ports @ 76.8 Kbps.

E. All building level controllers provided under this specification shall be required to provide the following simultaneous communication protocols and/or data links at a minimum:

1. ANSI/ASHRAE Standard 135: BACnet®.

   a. One (1) Point-to-Point (PTP): ANSI/ASHRAE Standard 135.10.

   b. One (1) Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.

   c. One (1) ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.

   d. Two (2) BACnet®/IP: ANSI/ASHRAE Standard 135 Annex J.

2. Modbus.

   a. Remote Terminal Unit (RTU) Master or Slave

   b. TCP Master or Slave

3. Simple Mail Transfer Protocol (SMTP).

   a. Transport Layer Security (TLS) for SMTP must be supported including compatibility with standard free email services (e.g., Gmail, Yahoo!, Outlook.com).

   b. The ability to manage custom TLS certificates from SMTP must be supported.

   c. The ability to transmit a simple test email to verify SMTP configuration with a single operator action (e.g., pressing a Test Email button) must be supported.

4. Simple Network Management Protocol (SNMP).

5. If Building Level Controller is also an Embedded BACnet® Operator Workstation it shall also support Hypertext Transfer Protocol (HTTP).

F. All inputs shall be provided with a proportional brightness LED to display the status of each individual input.

G. All outputs shall be provided with a proportional brightness LED to display the status of each individual output.

H. All hardware outputs shall be provided with a physical Hand/Off/Auto switch.

1. All analog outputs shall also be provided with a potentiometer for manual adjustment of voltage signal in the Hand position.

2. Hand/Off/Auto switch position feedback shall be monitored and displayed by the operating system of the controller.

3. Controller shall alarm when each Hand/Off/Auto switch is not in the Auto position.

3.15 BUILDING-LEVEL EQUIPMENT CONTROLLERS

A. Compliance. Building-level equipment controllers shall be provisioned as outlined in the Controllers execution clause and in compliance with this specification clause.

B. Provide one (1) building-level equipment controller per mechanical system and/or equipment as required per the contract documents, drawings, equipment schedules, and/or as follows:

1. All mechanical equipment and systems with a common application shall be provided with the same controller model.

C. BACnet Device Profile. Building-level equipment controllers shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L a minimum of 30 days prior to the bid date for this project as follows:

1. BACnet Building Controller (B-BC).

D. BACnet Network Architecture. Building-level equipment controllers shall be installed on the following network and data link:

1. Tier 2 Building Level Communication Network (BLCN).

a. BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.

E. BACnet Communication. All building-level equipment controllers shall be provisioned to support the following communication requirements:

1. A minimum of 1024 BACnet client network read requests and/or COV subscriptions and a minimum of 512 BACnet client network write requests and/or COV server notifications.

2. Automatically route between all enabled networks including but not limited to:

a. Between Tier 2 BLCNs.

b. Between Tier 3 FLCNs.

c. Between a Tier 2 BLCN and a Tier 3 FLCN.

d. Between a Tier 1 ELCN and a Tier 2 BLCN.

e. Between a B/VPN and a Tier 2 BLCN.

f. As a BACnet Broadcast Management Device (BBMD).

g. Between the BACnet internetwork and a Modbus network.

F. Physical Networking. All building-level equipment controllers provided under this specification are required to be provisioned such that the following physical communication networks at a minimum are intrinsic, licensed, and enabled simultaneously:

1. One (1) EIA-485 ports @ 76.8 Kbps.

2. One (1) of the following at a minimum:

a. One (1) ISO 8802.3 Ethernet (10/100 BaseT).

b. One (1) ISO 8802.3af PoE (10/100 BaseT).

c. One (1) ISO 8802.3b/g/n Wi-Fi.

G. Protocol. All building-level equipment controllers provided under this specification are required to be provisioned such that the following communication protocols and data links at a minimum are intrinsic, licensed, and enabled simultaneously:

1. ANSI/ASHRAE Standard 135: BACnet.

a. One (1) Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.

b. One (1) ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.

c. Two (2) BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.

2. Modbus.

a. Remote Terminal Unit (RTU); Master or Slave.

b. TCP; Master or Slave.

3. Dynamic Host Configuration Protocol (DHCP) as a client.

a. The ability for dynamic assignment of IP address, mask, and gateway by the DHCP server for the network shall be supported.

4. Simple Mail Transfer Protocol (SMTP).

a. Transport Layer Security (TLS) for SMTP must be supported including compatibility with standard free email services (e.g., Gmail, Yahoo!, Outlook.com).

b. The ability to manage custom TLS certificates from SMTP must be supported.

c. The ability to transmit a simple test email to verify SMTP configuration with a single operator action (e.g., pressing a Test Email button) must be provided.

5. Simple Network Time Protocol (SNTP) as a client.

a. The ability for embedded system time to be synchronized by an operator-configurable SNTP server shall be supported.

6. Transmission Control Protocol (TCP).

a. Connection to the BACnet internetwork utilizing standard BACnet services on Transport Layer Protocol (TCP) shall be supported, encrypting all data using SSL/TLS and secured using authenticated credentials and shall support custom encryption keys and authentication certificates.

7. Wi-Fi.

a. Devices with Wi-Fi provided under this specification must support WPA and WPA2 protected access.

8. OpenADR 2.0.

a. Virtual End Node (VEN) 2.0a at a minimum.

b. Must be certified by the OpenADR Alliance a minimum of 30 days prior to the bid date.

c. A Signed Declaration of Conformity and Protocol Implementation Conformance Statement (PICS) must be submitted for each device.

9. If any additional hardware including communication cards, ports, licenses or gateways are required to support these networks they must be provided as a part of this contract. Any additional hardware must be warranted by the manufacturer as proven by a certificate from the manufacturer for a period of five (5) years at a minimum.

H. Hardware. Building-level equipment controllers shall be installed and/or provisioned per the following requirements:

1. There shall be a provision for at least one spare, universal, software-selectable input on each building-level equipment controller after the requirements of the sequence of operation specified in the contract documents have been satisfied.

a. Where universal inputs are not available, one (1) spare analog input and one (1) spare binary input shall be required on each building-level equipment controller.

b. Where software-selectable inputs are not available, one (1) input of each required physical characteristic (e.g., thermistor, dry-contact, voltage, and current) shall be required on each building-level equipment controller.

2. There shall be a provision for at least one spare jumper-selectable output on each building-level equipment controller after the requirements of the sequence of operation specified in the contract documents have been satisfied.

a. Where outputs are not jumper-selectable to provide both universal and relay service, one (1) spare analog output and one (1) spare binary output shall be required on each building-level equipment controller.

3.16 FIELD-LEVEL EQUIPMENT CONTROLLERS

A. The field-level equipment controllers provided shall comply with all relevant sections of this specification.

B. Provide one (1) dedicated field-level equipment controller for the execution of global and local strategies for each mechanical system and/or building system piece of equipment.

1. Any application exceeding eight (8) inputs or eight (8) outputs shall not be considered a terminal unit application and shall require a dedicated field-level equipment controller or a building-level controller.

C. Each field-level equipment controller shall be provided with an integral power switch or a dedicated fused transformer and switch inside the enclosure.

D. All field-level equipment controllers provided under this specification shall be required to provide the following simultaneous intrinsic and enabled physical communication networks at a minimum:

1. One (1) EIA-232 port @ 115.2 Kbps.

2. One (1) EIA-485 ports @ 76.8 Kbps.

E. All field-level equipment controllers provided under this specification shall be required to provide the following simultaneous communication protocols and/or data links at a minimum:

1. ANSI/ASHRAE Standard 135: BACnet®.

a. One (1) Point-to-Point (PTP): ANSI/ASHRAE Standard 135.10.

b. One (1) Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.

F. All inputs shall be provided with a proportional brightness LED to display the status of each individual input.

G. All outputs shall be provided with a proportional brightness LED to display the status of each individual output.

H. All hardware outputs shall be provided with a physical Hand/Off/Auto switch.

1. All analog outputs shall also be provided with a potentiometer for manual adjustment of voltage signal in the Hand position.

2. Hand/Off/Auto switch position feedback shall be monitored and displayed by the operating system of the controller.

3.17 TERMINAL UNIT CONTROLLERS

A. The terminal unit controllers provided shall comply with all relevant sections of this specification.

B. Provide one (1) dedicated BACnet® Building Controller (B-BC) for each individual terminal unit.

C. Air Terminal Unit Controller Actuators. All air terminal unit damper actuators shall be brushless DC motors and shall be provided with the following at a minimum:

1. 45 in-lb (5 Nm) of torque.

2. Damper position feedback must be provided and programmed as a hardware analog input to the controller. Calculated damper position based upon active command time is not acceptable.

3. Damper-end/actuator-clutch switch must be provided and programmed as a hardware binary input to the controller to indicate that the actuator is at the end of the field-adjusted stroke. Switch must prove at 0% and 100% of the field-adjusted stroke of the damper. Calculated damper position based upon active command time is not acceptable.

4. Software selectable rotation allowing the drive-to-open direction of the actuator to be selected by an operator via the B-AWS.

D. Air Terminal Unit Controller Differential Velocity Sensor. All air terminal unit differential velocity sensors shall be provided with the following at a minimum:

1. ± 0-2 in w.c. (0-500 Pa) sensing range

2. Zero point accuracy of 0.0008 in w.c. (0.2 Pa)

3. Span accuracy of 3% of measured value

E. Air Terminal Unit Controller Test & Balance Calibration (T&B). Air terminal unit airflow sensor calibration shall be performed using the operator interface of the local zone communicating temperature sensor via a dedicated handheld configuration tool connected to each individual air terminal unit controller or at the B-AWS.

F. Where software and/or dedicated applications are required for airflow sensor calibration, the following must be provided to the Owner as a part of this specification at a minimum:

1. One (1) dedicated hardware platform to host the T&B and airflow calibration software and/or application independent from and in addition to any requirement for an operator workstation with a five (5) year warranty.

2. All software updates and support for five (5) years from the completion and acceptance of the project T&B report.

3.18 SPACE MOUNTED TERMINAL UNIT CONTROLLERS

A. The space mounted terminal controllers provided shall comply with all relevant sections of this specification.

B. All space mounted terminal controllers series under this specification shall be available with the following the integral hardware sensors at a minimum:

1. Temperature.
2. Set-point.
3. Relative Humidity (as indicated).
4. Bypass.
5. PIR Occupancy (as indicated).
    a. Range: 5m/16’.
6. CO2 (as indicated).

C. Each space mounted terminal controller shall be provided with a keypad and display to permit low-level operator interface with following features at a minimum:

1. Configurable back-lighting.
2. Configurable display icons, time, point names and engineering units.
3. Configurable to display and modify object values from any device on the internetwork.
    a. Provide access to a minimum of ten (10) total object values.
4. Provide the ability to view and modify Schedules.
5. Advanced application space mounted terminal controllers shall provide the following enhanced features:
    a. Provide access to a minimum of forty-eight (48) object values.
    b. View/Acknowledge Alarms.
    c. Annunciate unacknowledged alarms with display and audible notification.
    d. Multilayer password protected display.

3.19 COMMUNICATING SPACE SENSORS

A. The communicating space sensors provided shall comply with all relevant sections of this specification.

B. The communication status and reliability of all communicating sensors shall be actively monitored by the system. When communication is lost with any communicating sensor, the system shall be capable of generating an alarm and performing automatic control strategy response until communication is restored.

1. If the system is not capable of performing custom, freely-programmable and automatic control strategy response as a result of a loss of sensor communication, communicating sensors may be not be used.

C. Hardware. Communicating space sensors provided under this specification shall be available with the following the integral hardware at a minimum:

1. Temperature.

2. Set-point.

3. Relative Humidity (as indicated).

4. Unoccupied Bypass.

5. PIR Occupancy (as indicated).

a. Range: 5m/16’.

6. CO2 (as indicated).

D. Tamper-proof. Communicating space sensors provided under this specification shall be available as a stainless-steel or aluminum plate for tamper-proof applications in public spaces, corridors, restrooms, gymnasiums, etc.

1. Tamper-proof communicating space sensors shall cover a standard, single-device utility box.

2. Tamper-proof communicating space sensors shall be available with the following the integral hardware at a minimum:

a. Temperature.

b. Unoccupied Bypass (as indicated).

E. Except for in tamper-proof installations, each communicating space sensor shall be provided with a keypad and display to permit low-level operator interface with following features at a minimum:

1. Configurable display icons, time, point names and engineering units.

2. Configurable to display and modify object values from any device on the internetwork.

a. Provide access to a minimum of ten (10) total object values.

3.20 COMMUNICATING DUCT SENSORS

A. N/A

3.21 WIRELESS TEMPERATURE SENSORS

A. Wireless temperature sensors are not to be used.

3.22 AUTOMATIC CONTROL VALVES

A. Two-way valves shall not be placed on branch or main hydronic circuits where these valves will cause a "dead-head" pumping condition.

3.23 AUTOMATIC CONTROL ACTUATORS

A. Mount and link all control actuators according to manufacturer’s instructions.

1. Check operation of damper/valve and actuator combination to confirm that actuator modulates smoothly throughout full stroke to both open and closed positions.

2. To compress seats when spring-return actuators are used on normally-closed dampers, power actuator to approximately 5˚ open position, manually close the damper, and then tighten linkages.

B. All actuators shall be direct-coupled unless otherwise scheduled or indicated by manufacturer.

C. Minimum torque and power output requirements of actuators shall not be less than 125% of the required design load.

D. When the associated mechanical system or equipment is not in operation, control actuators shall remain in their “off” positions as indicated in the Sequences of Operation.

E. For automatic control valve actuators, In lieu of a manual positioning device, it will be acceptable for the contractor to provide a full line size bypass around the control valve. Three bypass shut off valves shall be provided to allow the control valve to be isolated while the bypass allows flow around the control valve.

3.24 TEMPERATURE DEVICES

A. All sensors shall be installed in accordance with the manufacturer’s recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings. Where necessary due to structural cavities, masonry walls, proximity to exterior openings, unconditioned spaces, etc. insulated mounting base shall prevent temperature of mounting location from affecting sensor temperature reading.

D. Space temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.

F. All averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

G. Low-limit sensors and/or thermostats used in mixing plenums shall be installed in a serpentine manner horizontally across the duct. Each bend shall be supported with a capillary clip. Provide a minimum of 3 m of sensing element for each 1 m2 (1' of sensing element for each 1 ft2) of coil area.

H. All pipe-mounted sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

1. Assembly shall allow removal of sensor from well without loss of measured medium fluid.

I. Outdoor air sensors shall be mounted outside on a northern exposure as high as serviceable on the building. The sensor shall be mounted within a ventilated enclosure to shield the sensor from the effects of the sun. The sensor location shall be selected such that it may not be affected by artificial and/or mechanical airstreams (i.e., building exhaust, building relief, etc.).

J. In condensing environments use stainless steel sensing element and capillary mounting clips.

K. Sensor guards shall be provided to protect sensor from damage in high-impact and/or high-traffic areas and/or where vandalism is a concern.

L. Sensors shall be manually calibrated on site so that the wiring length and termination does not detract from the specified sensor accuracy.

3.25 HUMIDITY DEVICES

A. All sensors shall be installed in accordance with the manufacturer's recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification.

B. Duct mounted humidity sensors should be installed in ducts at least ten (10) duct diameters from any equipment that adds moisture to the air stream to allow for mixing and preventing inaccurate readings. Insure foam backing is in full contact and completely sealed. Any element sealing caps protecting the sensing element must be left in place until the sensor is installed to prevent sensor contamination.

C. Outdoor humidity sensors should be mounted under an eave, shield, or in an area out of the weather or direct sunlight. The sensing element should be pointed down. The transmitter must be in a weather tight enclosure properly sealed to prevent moisture from entering. Raceway penetrations from inside to outside must be sealed to prevent warm moist air from condensing on the transmitter and/or sensing elements.

D. Space humidity sensors shall be installed on concealed junction boxes properly supported by the wall framing. Space humidity sensors should be mounted away from areas that may produce moisture such as sinks, coffee pots etc. and equipment that will produce temperatures that are not representative of the actual space temperature.

3.26 THERMAL ENERGY METERS

A. Not included under this project's scope.

3.27 ELECTRICAL ENERGY METERS

A. Not included under this project's scope.

3.28 CURRENT TRANSMITTERS

A. Current transmitters shall be installed in accordance with the manufacturer's recommendations, NEC, and AHJ consistent with acceptable industry standards for performance compliant with the requirements of this specification.

3.29 VOLTAGE TRANSMITTERS

A. Voltage transmitters shall be installed in accordance with the manufacturer's recommendations, NEC, and AHJ consistent with acceptable industry standards for performance compliant with the requirements of this specification

3.30 PRESSURE SENSORS

A. All sensors shall be installed in accordance with the manufacturer's recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification

B. Locate all air pressure transducers (except for those controlling air terminal units) in field device panels, not on mechanical equipment or ductwork, as close as possible to the sensing point and use tubing sized so as to prevent signal phase lag.

C. Air pressure transducer tubing shall be connected to a pitot tube or other pressure/airflow sensing device. Under no circumstances shall tubing pass through equipment housing or ductwork.

1. Pitot tube probe shall be made of brass or aluminum with 8 inches of lead tube allowing insertion into duct.

D. The piping to air pressure ports on all pressure transmitters shall contain a capped test port adjacent to the transmitter.

E. Static pressure sensing taps shall face down-stream in the airflow so as to eliminate velocity pressure effects.

1. Supply and return air duct static pressure transmitters shall have the high-pressure port connected to a pitot tube installed in the ductwork and the low pressure port shall be left open to the plenum.

F. Supply air duct static pressure transmitter pitot tubes shall be located 60-70% of the total distance from the fan unit and in a straight section of ductwork with a minimum or four (4) duct diameters/widths in both directions.

G. Positive static high-pressure safety cut-outs shall be located immediately downstream of the fan section and shall have the high-pressure port connected to a pitot tube installed in the ductwork and the low-pressure port shall be left open to the plenum.

H. Negative static high-pressure safety cut-outs shall be located immediately upstream of the fan section and shall have the low-pressure port connected to a pitot tube installed in the ductwork and the high-pressure port shall be left open to the plenum.

I. Building static pressure sensors high-pressure port connected to a sensing probe installed in the space and the low-pressure port connected to an outdoor air static pressure sensing probe through a high-volume accumulator. The tubing for both the high-pressure and the low-pressure ports shall be routed through a surge dampener installed between the transmitter and the sensing elements.

J. Differential pressure taps shall be installed such that true differential of the monitored medium may be accurately sensed.

K. Wet pressure sensors shall be installed with integral snubbers and isolation valves.

1. Wet pressure sensors shall be plumbed to the side or top of pipe as per manufacturer's recommendations to prevent sediment from affecting sensor accuracy.

2. Wet pressure sensors shall be provided with shut-off valves if not provided by mechanical contractor. Coordinate piping connections with mechanical contractor.

3. Wet differential pressure transmitter display shall be installed within the length of the factory fabricated cables. Cable extenders shall not be acceptable. Sufficient cable slack shall be left to provide strain relief at both ends.

4. Sensor threads are to be covered with PTFE tape or other thread sealing alternative.

L. Differential pressure type switches shall be installed as per differential pressure transmitters and shall provide a maximum switching differential of 10% of the sensed operating range for the application at minimum and maximum designed flow rates. Set-point shall be selected to operate at midpoint of span.

3.31 TEMPERATURE CONTROL PANELS

A. Unless otherwise directed by the AHJ, all temperature control panels and enclosures shall be located as indicated such that visual observation and adjustment can be accomplished while standing flatfooted on the floor in a convenient location adjacent to the equipment served. Install all equipment in readily accessible location as defined by Chapter1 Article 100 Part A of the NEC or CSA C22.1-12 Rule 2 (as applicable).

B. All temperature control panels shall have keyed, locking latches and shall be keyed commonly such that one key shall open all enclosures.

C. Provide each DDC panel with a surge suppressor, electrical disconnect, control fuse, and control transformer; all sized and provided by the control system contractor.

D. Interconnections between internal termination points and face and/or panel-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL-Listed for 600 volt service, individually identified per control drawings with adequate clearance for field connections.

1. Provide insulated, modular, feed-through, clamp-style recessed captive screw-type terminal blocks suitable for rail-mounting with end plates and partitions for the termination of all field wiring in temperature control panels.

2. Field wiring to equipment with integral terminals and/or unitary equipment shall not be required to have terminal blocks.

E. All high-voltage wiring consistent with the definitions of NEC/CSA Class 1 and all low-voltage wiring consistent with the definitions of NEC/CSA Class 2 must be strictly separated by barriers, raceways or sub-panels according to the requirements of the NEC Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits and the CSA Canadian Electrical Code, Part 1 Rule 16-212 Separation of Class 2 circuit conductors from other circuits.

F. Provide laminated nameplates or tags for all control system panels. Unless otherwise directed in this specification or by the AHJ, nameplates shall be minimum 1 inch by 3 inches (2.5 cm X 7.5 cm), with minimum ¼ inch (6 mm) high block lettering. Nameplates for devices smaller than 1 inch by 3 inches (2.5 cm X 7.5 cm) shall be attached to adjacent surface.

G. Control panel components within the enclosure shall be labeled with printed stick-on labels indicating each component as it appears on the control drawings. Labels are to be black lettering with white background, minimum 1/4" character height. Hand written labeling shall not be acceptable.

H. A legible reproduction of the "As-built" application engineering for the system served shall be place in a clear plastic pouch permanently mounted within each enclosure. These "As-builts" shall include all of the drawings associated with the system(s) which are being controlled with a particular panel.

3.32 POWER SUPPLIES AND LINE FILTERING

A. All connected loads shall not exceed 80% of the faceplate rating for each power supply or transformer.

B. Power supplies shall be sized to include required spare point capacity without exceeding the 80% rating above.

3.33 WIRING

A. Building Automation System (BAS) control wiring shall be performed by professionals in a workmanlike manner consistent with acceptable industry standards for performance and in compliance with the contract documents, Project Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ). When non-code compliance requirements of the Electrical System Specifications and this specification section differ, this section shall take precedence.

B. Unless otherwise specified it shall be the responsibility of the Building Automation System (BAS) Contractor to provide all of the wiring necessary to provide a complete Building Automation System (BAS) in compliance with the requirements of this specification.

C. All wiring consistent with the definitions of NEC/CSA Class 1 (line voltage) shall be installed in UL-Listed raceway or conduit according to the requirements of the NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.

D. All wiring consistent with the definitions of NEC/CSA Class 2 (low voltage) control wiring shall be sub-fused as required and installed according to the requirements of the NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.

E. Class 2 wiring concealed in accessible locations not installed in UL-Listed raceways or conduit may be used provided that the cable is UL-Listed for the intended application.

F. When Class 2 wiring is installed exposed, wiring is to be routed parallel or perpendicular (right-angles) with building and/or mechanical lines and neatly tied at 2 m (6’) intervals.

1. Exposed cabling shall be mechanically supported to structural members with D-rings or an equivalent device specifically designed for this purpose.. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping or ceiling suspension systems.

2. Exposed cabling shall be installed in sleeves where the route passes through walls, floors and other partitions. Maintain fire, smoke, envelope and pressure ratings of each space.

3. All wiring in mechanical, electrical or service rooms, or where subject to mechanical damage shall be installed in UL-Listed raceway or conduit.

G. Class 2 wiring shall not be installed in in raceways or conduit containing Class 1 wiring. Junction boxes, enclosures and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays, transformers, CTs, etc.). Refer to the requirements of the applicable code enforcing authorities and AHJ.

1. NEC Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits.

2. CSA C22.1-12 Rule 16-212 Separation of Class 2 circuit conductors from other circuits

H. Sizing and selection of raceways, enclosures and conduit shall be the responsibility of the Building Automation System (BAS) Contractor in keeping with the manufacturer's recommendations and the requirements of NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.

1. Conceal all raceways and conduit, except within mechanical, electrical or service spaces.

2. Install raceways and conduit to maintain a minimum clearance of 15 cm (6") from high-temperature equipment (e.g., steam lines, flues, etc.).

3. Secure and support raceways and conduit to the structure per the manufacturer's recommendations. Raceways and conduit may not be hung on flexible straps or tie rods, nor may they be attached to ductwork.

4. Comply with the requirements of the Electrical System Specifications when raceways or conduit crosses building expansion joints.

5. Include a minimum of one (1) pull string in each raceway or conduit extended a minimum of 15.2 cm (6").

I. Flexible metal raceways, liquid-tight and other non-rigid conduit shall not exceed 1 m, (3') in length and shall be mechanically supported at each end.

1. Flexible metal raceways, liquid-tight and other non-rigid conduit smaller than 12 mm (0.5") shall not be used.

J. Wire-to-device connections shall be made in enclosures or approved junction boxes with a maximum fill of 50%.

1. Devices with terminals shall be terminated at the device terminals. Splices will not be permitted.

2. Wherever possible device terminations shall be made in the enclosure provided with the device.

K. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

L. Use color-coded conductors consistently throughout the entire Building Automation System (BAS) installation.

M. Maximum allowable voltage for control wiring shall be 120 volts.

N. The Building Automation System (BAS) Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

O. Maximum pulling, tension, and bend radius for cable installation as specified by the manufacturer shall not be exceeded during installation.

P. The Building Automation System (BAS) Contractor shall verify integrity of all wiring to ensure continuity and freedom from shorts and grounds after the installation is complete.

Q. When any cable enters or exits the building a lightning arrestor must be installed between the conductors and ground. The lightning arrestor shall be installed according to the manufacturer's recommendations.

3.34 COMMUNICATION WIRING

A. Communication and network wiring shall adhere to the Wiring article in Part 3 of this specification and the manufacturer's recommendations.

B. Communication wiring shall not be installed in any raceway or conduit with Class 1 wiring.

C. All communication wiring shall be installed as continuous lengths, with no splices permitted between termination points.

D. All communications wiring shall be a consistent color designated for the particular network. MS/TP networks shall be of one color end to end. Color changes shall not be permitted. All CAT6/CAT5E cabling shall be the same color.

E. All communication cabling shall be labelled to indicate origination and destination devices.

F. All communications shielding shall be grounded as per manufacturer's recommendations and in accordance with the NEC/CSA (as applicable).

3.35 IDENTIFICAITON OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels shall be labelled at each end within 5 cm (2") of the termination with the BACnet® object instance or termination number.

B. Manufacturer's name plates and UL or CSA labels are to be visible and legible after equipment is installed.

C. All labels and identifiers shall match record documents.

D. All wiring labels are to be created with a label maker. Hand-written labels shall not be acceptable.

3.36 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and data logging with a minimum of 25% of available memory remaining free for future use.

B. Utilize a device addressing scheme that is appropriate for the requirements of the physical media as well as being such that it can be consistently expanded over the entire campus. Simply relying on factory default addressing will not be acceptable. This scheme shall be subject to owner approval.

C. At time of acceptance, all operating systems, Building Automation System (BAS) software and hardware shall be the latest official release version available.

D. Unless otherwise specified, Building Automation System (BAS) shall be programmed using a standard naming convention. Objects names shall be modular in design, allowing easy operator interface without the use of a written object index. Use the following naming convention: AA-BBBBCCC-DDDDEE where:

1. AA is used to designate the service location (e.g., room, floor, building, etc.).

2. BBBB is used to designate the mechanical system with which the object is associated (e.g., AH, CHWS, HTG, CLG, LTG, etc.).

3. CCC represents specific mechanical systems or pieces of equipment (e.g., 01, etc.).

4. DDDD represents the equipment, device or material referenced (e.g., SF (supply fan), RF (return fan), DA (discharge air), etc.).

5. EE represents the action or state of the equipment or measured medium (e.g., T (temperature), RH (relative humidity), P (pressure), etc.).

E. Program the Building Automation System (BAS) to adhere to this specification and to fully incorporate the features described. Optimize the program to provide the Sequences of Operation, minimize energy consumption and prolong equipment life.

1. All Building Automation System (BAS) programming necessary for the operation of the system to satisfy the design intention and performance requirements, but not specified in this document, shall be provided by the Building Automation System (BAS) Contractor at the direction of the Engineer.

2. Imbed in the programming sufficient comment statements and descriptions to clearly describe each section of the program. Comments shall reflect the language of the specified sequences of operation.

F. Provide graphical user interface (GUI) consistent with the requirements of this specification and the Sequences of Operation. At a minimum:

1. Provide dynamic graphics for all mechanical systems and/or each individual piece of mechanical equipment.

2. All physical hardware, sensors, control devices and set-points shall be visible in graphical format.

G. All hardware inputs shall be programmed with appropriate alarms, configured to indicate genuine alarm conditions and/or failure to control while preventing nuisance alarm notification.

H. Unless otherwise specified, all set-points shall be adjustable.

I. At a minimum, every analog hardware point shall be trended and every binary hardware point shall have active and cycle times logged consistent with the specification requirements for trend logs and runtime logs. At a minimum, all software (virtual) set-points, control loops and operational modes shall be likewise trended and/or logged.

1. Interrelated objects shall be logically grouped into Trend Log Multiple objects for individual mechanical and building systems. Unless otherwise scheduled, initial set-up shall be to log values once every 15 minutes.

J. The system shall observe the following standard BACnet® command priorities (from highest to lowest):

1. Smoke Control and Life Safety (Priority Level 1 & 2).

2. Manual Operator Command (Priority Level 8).

3. Energy Management (Priority Level 9).

4. Normal Automatic Control (Priority Level 10).

3.37 TEST & BALANCE

A. The Building Automation System (BAS) Contractor shall provide a single set of all tools required to interface with the System for the purposes of Test & Balance.

B. The Building Automation System (BAS) Contractor shall provide instruction in the use of all tools required to interface with the System for the purposes of Test & Balance.

C. The Building Automation System (BAS) Contractor shall provide a qualified technician to assist in the test & balance for a period of eight (8) hours or until the first twenty (20) terminal units have been balanced.

3.38 BUILDING AUTOMATION SYSTEM (BAS) CHECK-OUT AND TESTING

A. All testing listed in this article shall be performed by the Building Automation System (BAS) Contractor. This testing shall be completed before system demonstration is initiated.

1. The Building Automation System (BAS) Contractor shall furnish all of the necessary labor and test and calibration apparatus required to calibrate and prepare for service all instruments, controls, and accessory equipment provided under this specification.

2. Verify that all control terminations are tight and all control wiring is proper and free from shorts and faults.

3. Enable normal operational control and verify calibration of all input devices individually according to manufacturer’s recommendations.

4. Verify the operation of all output devices including action, normal positions, fail-safe positions, start and span, and travel.

5. Set all set-points to their initial and/or startup values prior to testing against specified sequences.

6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation.

a. Tune all control loops and optimum start/stop routines.

b. Check each alarm separately by providing an appropriate signal to trip the alarm.

c. Trip all safeties and interlocks to verify proper operation and fail-safe response.

B. As each device is tested a log shall be completed showing the date, technician's initials and any corrective action taken as a result of operational failures. This log shall be submitted prior to scheduling acceptance demonstration and for inclusion in the final O&M manuals.

3.39 CONTROL ACCEPTANCE AND DEMONSTRATION

A. Prior to acceptance, the Building Automation System (BAS) shall undergo a series of performance tests to verify proper operation and compliance with this specification.

B. In order to begin the acceptance process, the system must operate alarm free for one hundred and twenty (120) hours. This time period begins over for any alarm unless the contractor initiates a review process with the Owner's designee, the Commissioning Agent, and the design team. This team may determine that the alarm(s) was a result of circumstances beyond the control of the Building Automation System (BAS) Contractor

C. The tests described in this section are in addition and subsequent to the tests necessary for start-up, tuning, debugging and compliance with the requirements of the Check-out and Testing section of this specification. The Engineer or an appointed representative shall be present at the tests specified in this section and shall be notified ten (10) working days prior to the testing procedures.

D. The Building Automation System (BAS) Contractor shall provide at least two (2) qualified technical personnel equipped with means for two-way communication to demonstrate the actual operation of all control operations and modes including occupied, unoccupied, seasonal changeover and emergency/fail-safe operation.

1. Compliance with this specification shall be demonstrated including all specification sections, schedules, drawings and Sequences of Operation.

E. Demonstrate operator interface compliance with the requirements of the specification.

F. Additionally, the following shall be demonstrated:

1. Control loop response shall be proven in the form of trend data in a graphical format displaying the actual response to process variables of each control loop.

a. Trends shall include the process variable, set-point, loop output and physical output position.

b. Trends shall show the loop's response to a change in set-point.

c. The sampling rate shall be between 10 seconds and 3 minutes.

d. Leading or following loops shall be required to be tuned by the Building Automation System (BAS) Contractor.

2. Operational logs for each system that demonstrate normal operation.

    a. Trends shall include the process variable, set-point, loop output and physical output position, operational mode and equipment status.

    b. Trends shall cover three (3) 48-hour periods with a sampling interval of not more than 10 minutes.

3. At the discretion of the Owner/Engineer trends from a random sampling of 25% of unitary controllers/applications may be submitted.

4. Database backup of the entire network and database restoration for selected controllers.

G. As each device is tested a log shall be completed showing the date, technician's initials and any corrective action taken as a result of operational failures.

H. The Building Automation System (BAS) Contractor shall display using a third-party data packet analytical tool that all Building Automation System (BAS) data including operator interface requests are being performed using BACnet®.

1. Any tests that fail to demonstrate the operational compliance of the Building Automation System (BAS) shall be repeated at a later date when the issues have been resolved. The Building Automation System (BAS) Contractor shall be responsible for any necessary repairs or revisions to successfully complete all tests.

I. When all of the tests and documentation described herein have been successfully completed to the satisfaction of the specification, the Owner and the Engineer the Building Automation System (BAS) shall be accepted as complete within fourteen (14) calendar days.

J. Any tests that cannot be performed due to circumstances beyond the control of the Building Automation System (BAS) Contractor may be performed at the discretion of the Owner after acceptance and as a part of the warranty period.

3.40 CLEANING

A. The Building Automation System (BAS) Contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his/her control as soon as their contents have been removed.

B. At the completion of work in any area the Building Automation System (BAS) Contractor shall clean all work, equipment, etc. keeping it free from dust, dirt, debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any other factory finish damage shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed or damaged shall be replaced with new material and painted to match the adjacent areas.

3.41 TRAINING

A. The Building Automation System (BAS) Contractor shall provide instruction on the adjustment, operation and maintenance of the Building Automation System (BAS) including all hardware and software provided and installed in compliance with the requirements of this specification.

1. Training shall be performed by a manufacturer's representative and/or instructor or a manufacturer-trained application engineer and/or technician with sufficient experience in the installation, programming and operation of the Building Automation System (BAS).

2. All training equipment and material shall be provided by this Contractor.

B. Training in the operation of the Building Automation System (BAS) shall be performed utilizing a BACnet® network of working controllers representative of the installed network and/or the Owner's facility and shall include:

1. Overview of the installed system and network architecture.

2. Building Automation System (BAS) components.

3. Graphical User Interface (GUI) operation.

4. Day-to-day operations including modification of system set-points, schedules, calendars, manual overrides, trending, log retrieval, alarm handling, etc.

5. Software operation, including navigating the workstation displays, database management, troubleshooting, diagnostics, report generation, etc.

6. Database design and modification including adding objects, modifying routines, optimizing operation, etc.

7. General operation of the workstation hardware and peripherals.

C. On-site walk-through shall cover the deployment and execution of the complete Building Automation System (BAS) and components including:

1. Sequences of Operation.

2. Location of all panels, enclosures, controllers, devices, sensors, etc. and equipment and panel lay-out.

3. Hardware preventive maintenance, calibration, troubleshooting, maintenance and repair.

4. Proper use of service tools and materials.

3.42 INSTRUCTIONS TO OTHER CONTRACTORS

A. Control Valve Installation. Control valves shall be installed in accordance with the manufacturer's recommendations and in compliance with this specification.

1. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal positions.

2. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.

3. Isolation valves shall be installed so that the control valve body may be serviced without draining the piping system. Unions or flanges shall be provided at all connections to control valves.

4. Provide tags for all controls valves indicating service and identifier. Secure tags with chain and hook. Identifiers shall match approved control shop drawings.

B. Control Damper Installation. Control dampers shall be installed in accordance with the manufacturer's recommendations and in compliance with this specification.

1. Damper submittals shall be coordinated for type, quantity and size to ensure compatibility with sheet metal design.

2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Inside clear duct openings shall measure 6 mm (1/4") larger than damper actual outside clear dimensions and shall be square, straight and level.

3. Individual damper sections as well as entire multiple section assemblies must be completely square and free from racking, twisting or binding. Diagonal measurements from upper corners to opposite lower corners must be within 3 mm (1/8") of one another.

4. Unless specifically designed for vertical blade orientation, dampers must be installed with blade axis horizontal.

5. Damper blades, shafts, and linkages must operate without binding. On multiple section assemblies, blades must open and close simultaneously.

6. Provide a visible and accessible indication of damper position on the drive shaft end.

7. Support ductwork in area of damper when required to prevent sagging due to damper weight.

8. After installation caulk between frame and duct and/or opening to prevent leakage around perimeter of damper.

C. Original Equipment Manufacturer Provided Controls. All OEM package DDC devices provided for this project shall completely comply with all of the requirements of this specification section.

1. Provider of the OEM equipment/controls shall bear exactly the same burden of responsibility for products provided in other sections of this specification as the Building Automation System (BAS) Contractor.

2. A Protocol Implementation Conformance Statement (PICS) including a BACnet® Interoperability Building Block (BIBB) table shall be provided for any DDC device (hardware and software) provided to be integrated to the Building Automation System (BAS).

3.43 SEQUENCES OF OPERATIONS

A. Refer to plans and specifications for indications of the intended control functions, devices and sequencing.

B. The Building Automation System (BAS) Contractor shall be responsible for all control wiring connections, auxiliary devices, and control wiring diagrams to complete the control system and attain the described sequence of operation.

C. All set-points of thermostats, controllers and the like, that are not factory preset, shall be preset by the Temperature Control Contractor before system startup.

D. Safety Interlocks General

1. All safety interlocks shall be hard wired and independent of control system programming software, and DDC controllers. These safety interlocks include the shutdown of equipment items due to low temperature, high temperature, high pressure, low pressure, lack of combustion air supply and/or proper flue draft for fuel fired equipment, and shutdown due to smoke detection or activation of the fire alarm system.

2. The Division 26 fire alarm system shall supply one (1) set of contacts at each air handling unit that is controlled by the Building Automation System (BAS). This safety interlock is to be hard-wire interlocked as described above for system shut down of the associated HVAC system including return fans, exhaust fans and other associated equipment as designated.

3. The Firefighter’s Smoke Control Override Panel shall override the interlocked equipment shut-down as indicated by the smoke control sequences.

E. Heating Water System

1. Boilers

a. The condensing boiler shall be enabled/disabled by the BAS through a hardwired set of contacts. The integral controls on each boiler shall respond to their respective integral safety interlocks.

b. Hardwired alarm contacts shall be wired back to the BAS and appropriate action as described below shall be initiated by the BAS upon receipt of an alarm condition.

c. Hardwired burner status contacts shall wired back to the BAS and close whenever the burner is on.

d. Firing rate, leaving water set-point and the rest of the available boiler data shall be integrated via a BACnet interface back to the BAS.

2. Graphics pages

    a. Graphics pages shall depict position values as a percent open in all cases.

    b. Graphics pages shall depict speed values as percent speed 0-100%.

F. Chilled Water System

1. Chiller

    a. The chiller shall be enabled/disabled by the BAS through a hardwired set of contacts. Upon startup an integral set of pump call contacts shall be wired back to the BAS to initiate a variable-primary chilled water pump start. The integral controls on the chiller shall monitor a set of contacts hardwired from the BAS to indicated proven pump status.

    b. Hardwired alarm contacts shall be wired back to the BAS and appropriate action as described below shall be initiated by the BAS upon receipt of an alarm condition.

    c. Hardwired chiller run status contacts shall wired back to the BAS and close whenever the chiller is running.

    d. Chilled water set-point, demand limiting and the rest of the available chiller data shall be integrated via a BACnet interface back to the BAS

2. Graphics Pages

    a. Graphics pages shall depict position values as a percent open in all cases.

    b. Graphics pages shall depict speed values as percent speed 0-100%.

G. Air Handling Units

1. The AHU(s) consist of a variable volume air handling unit equipped with VFD modulated supply and return fans, economizer with mixing box section, hydronic pre-heat and cooling coils.

2. System safeties and interlocks

    a. The system shall be equipped with the following interlocks and safeties:

        1) Fire alarm contacts

            a) The fire alarm system contractor shall provide a set of dry contacts to the BAS contractor that shall open in the event of a fire alarm.

            b) The fire alarm contacts shall be wired in series with other interlocked safety devices. Should these contacts open, the system shall shut down and all final control elements except, the pre-heat coil valve and pump, shall go to their failsafe positions. An alarm shall be annunciated by the BAS.

3. Additional points

   a. The BAS contractor is to provide individual start/stop, run status, speed signal, fault status and BAS integration for each VFD. A common signal to or from multiple VFDs shall not be acceptable.

   b. In addition to those points specifically required to meet the intent of the sequence of operation the BAS contractor is to provide all additional points detailed in the plans and specifications. This includes but, is not limited to, points like filter status, outside air temperature/humidity etc...

END OF SECTION 250000

DIVISION 27

COMMUNICATIONS

27.05.53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Refer to Section 26.05.53 Identification for Electrical Systems which are hereby made part of Division 27 - Communications.

B. Refer to other Division 27 Specification Sections for specific identification requirements

1.02 COMMUNICATIONS SYSTEMS IDENTIFICATION

A. Identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. Structured Cabling System

C. Paging System

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 STRUCTURED CABLING SYSTEM

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein.

B. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be labeled utilizing a permanent labeling system. DYMO style labels, or handwritten labels WILL NOT BE ACCEPTED.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application and system testing.

D. Systems tests shall reference the final labeling.

E. Nameplates shall be secured with screws, one on each end.

END OF SECTION

27.11.00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The intent of this specification section is to cover the materials and installation of a communications equipment room fitting system as outlined herein and as detailed on the drawings. Work shall consist of:

1. Telecommunications Room (including the PBX Room) termination and cable management including racks, cabinets, ladder rack, backboards, backboard mounted wire management, etc.
2. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.
3. Cable management system within racks and cabinets.
4. System labeling conforming to ANSI/TIA-606-B standards and as supplemented and modified by proposed ANSI/TIA-942-A-2012 Data Center Standards and ANSI-BICSI- 002-2011 Data Center Design Standards.

1.02 SYSTEM DESCRIPTION

A. Termination Equipment – Racks and Cabinets

B. Cable Management – Ladder rack, rack mounted horizontal and vertical cable management, backboards, backboard mounted cable management.

C. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.

1.03 QUALITY ASSURANCE

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA. BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.04 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Supplier shall provide rack elevations showing the configuration of all rack mounted

equipment including detailed interconnection diagrams between equipment

1.05 RELEVANT STANDARDS

A. The structured cabling installation shall comply with the following at a minimum:
   1. All local, state and national codes.
   2. The National Electric Code (NEC)
   3. The National Electrical Safety Code (NESC)
   4. Electronic Industries Association (EIA) / Telecommunications Industry Association (TIA) ANSI/TIA-526-14-C, ANSI/TIA-568-C, ANSI/TIA-569-C, ANSI/TIA-598-D, ANSI/TIA-606 B, ANSI/TIA-607-B, ANSI/TIA-758-B and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.01 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.02 FREE STANDING 19 INCH RELAY RACKS

A. Open style data racks shall be 19 inches wide, 84 inches high, and shall meet EIA standards. Racks shall be listed to the UL 1863 Standard for Communication Circuit Accessory. Both vertical and horizontal cable management systems must be provided on all relay racks. All racks must be grounded to the building technical grounding system.

B. Provide a full height front/rear vertical wire management panel with covers with integral cable spools with each floor mounted rack on each side. Where multiple racks are ganged together, there shall be one vertical wire management section between each two racks and one additional section at each end of the line-up.

C. Provide one - six outlet power strip with integral surge suppression and a 10 ft. cord with 20A plug in each rack. Each plug strip to connect an dedicated outlet on the building UPS/Generator. Refer to drawings for quantities and locations.

D. Coordinate location at each rack with Owner.

E. Relay Racks shall be manufactured by Chatsworth and shall utilize the CPI Evolution series full height cable management system.

F. Refer to drawings for quantities and arrangement.

2.03 OVERHEAD CABLE BASKET TRAY

A. Runway shall be tubular steel, ladder type with 2 or 4-inch stringer height with welded rungs. Refer to plans for width. Stringer side rail shall conform to the minimum chemical and mechanical properties of ASTM A513 Grade 1008 steel.

B. Cable runway shall be flat white powder coat including all hardware and accessories.

C. All fittings, supports, splices, etc. for the runway system shall be installed to provide a complete assembly – including fasteners, hardware and other items required to complete the installation as indicated on the drawings.

D. Cable runway shall be capable of carrying a uniformly distributed load of 95 lbs./ft. on a 5-foot support span with a safety factory of 1.5 when supported as a simple span. Load and safety factors specified are applicable to both side rails and rung capacities.

E. Cable basket tray as manufactured by B-Line, Damac, Hubbell, ICC, Great Lakes, or Cablofil.

F. Refer to drawings for quantities and arrangement.

2.04 PDU - PROVIDE THE FOLLOWING PDU UNITS IN EACH TR:

A. Provide all required 120V and 280V power distributed units through rack as required by installed equipment:

1. PDU’s shall have IP monitoring and switchable outlets.
2. PDU’s shall be “zero-U” mounting with the cord exiting the top of the PDU. A minimum cord length of 6’ is required. Refer to drawings for locations.
3. PDU shall have an onboard display.
4. PDU shall have the ability to connect to other types of sensors (such as a thermal probe).

B. Data 2 (Rows A & B)

1. Input - 208V-3PH-30A L21-30R
2. Output - IEC C13/C19 receptacles

C. Data 1 (Rows A & B)

1. Input - 208V-1PH-30A L14-30R
2. Output – NEMA 15/20R receptacles

D. Voice/Systems (Rows A & B)

1. Input - 208V-1PH-30A L14-30R
2. Output – NEMA 15/20R receptacles

E. Acceptable manufacturers: Liebert MPH2 series.

2.05 INNERDUCT

A. Exterior Innerduct – Flexible corrosion-resistant innerduct with corrugated interior and crush resistant construction. Innerduct to be available in a variety of multi-cell construction, colors and shall range in individual cell size from ½ inch to 2-inch I.D. Refer to plans for specific size.

B. Interior Innerduct – UL listed, plenum rated, flexible innerduct, corrugated with pull line. All interior fiber optic cables shall be installed in innerduct.

C. Refer to drawings for quantities and arrangements.

2.06 BACKBOARDS

A. Where shown on the drawings / on all walls in the PBX Room, backboards shall be provided for wall mounting of devices and technology equipment.

B. General

1. Backboard shall be 0.75-inch-thick waterproof flame retardant plywood secured to structure.
2. Each board shall be painted with fire retardant paint. The manufacturer's fire rating stamp hall not be painted over and shall remain visible.
3. Backboards shall be normally 4 ft. x 8 ft. mounted 6 inch above floor. Where other sizes are required, they will be noted on the drawings.

C. Refer to drawings for quantities and arrangement.

2.07 BACKBOARD MOUNTED CABLE MANAGEMENT

A. D-Rings

1. 1. Non-conductive, smooth bearing. Available in 2x2, 3x3, 3x5. Size as required for 50 percent spare capacity.
2. Provide on backboards for management of cabling.

B. Slotted Raceway

1. Provide non-metallic, wall mounted slotted raceway with covers, Available in 2x2/3x3/4x4. Refer to plans for locations. Size as required for 50 percent spare capacity.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Refer to drawings for quantity and arrangement of Telecom Room equipment.

B. Where cabling is routed along backboards, utilize wall mounted cable management systems to provide cable support at an interval no less than 60-inch O.C.

C. Telecommunications Rooms – Provide ladder rack in telecommunications rooms in configurations as indicated on the drawings.

3.02 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Provide ladder rack and cable basket tray in telecommunications rooms in configurations as required by final room layout.

C. Coordinate layout of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

D. Coordinate layout of telecom rooms with electrical plans and locations of electrical outlets.

E. Layout of telecommunications equipment cabinets and racks shall provide a minimum of 36-inch isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

F. Within the various telecom rooms, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need additional coordination.

3.03 GROUNDING

A. All racks, ladder racking, and basket tray shall be grounded to the Telecommunications ground busbar in the PBX Room.

3.04 PROGRAMMING – Not Applicable

3.05 IDENTIFICATION/LABELING

A. The Contractor shall be responsible for labeling all supplied communications equipment, in accordance with the guidelines as described herein.

B. Equipment racks/cabinets shall be labeled to indicate closet designation and sequential number within each closet.

C. On renovation projects where there already exists a numbering scheme, this contractor shall be responsible for maintaining and extending that numbering scheme as directed by the Owner.

D. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.06 TESTING - Not Applicable

3.07 COORDINATION WITH COMMUNICATIONS SERVICE PROVIDERS – Not Applicable

3.08 TRAINING REQUIREMENTS – Not Applicable

3.09 AS-BUILT DOCUMENTATION

A. Copies of all approved shop drawings with the Engineer's stamp.

B. 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 digital media with electronic versions of Owner's manuals. Digital media containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

1. 1. Racks/Cabinets
2. 2. Ladder Rack
3. 3. Power Strips
4. 4. Cable Tray

C. 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.

1. 1. AutoCAD architectural floor plans at a scale of 0.25 inches=1 foot-0 inches on 30x42, 24x36 size sheets showing the telecommunications equipment layout in each IDF closet and the MDF closet. This layout shall include the racks, backboards, cable tray, conduit sleeves, 120V power, etc. Each piece of equipment where labeled in the field shall have the corresponding label on these plans. These drawings shall be as-built conditions.

3.10 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

27.13.13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings.

Work shall consist of:

1. Voice and data backbone cabling between telecommunications rooms including termination, testing, and labeling.
2. Voice and data backbone cabling between buildings including termination, testing and labeling.

1.02 SYSTEM DESCRIPTION

A. Voice and Data Backbone Cabling System shall consist of:

1. 1. Voice backbone cabling as specified herein from the new CORE ROOM B to each TR and from CORE ROOM A to CORE ROOM B. Refer to the drawings for specific cabling requirements.
2. Voice intra-building backbone cables as specified herein. Refer to drawings for specific requirements.
3. Termination, Testing, and labeling.

1.3 QUALITY ASSURANCE

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA. BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.04 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.05 RELEVANT STANDARDS

A. The Structured Cabling Installation shall comply with the following at a minimum:

1. All local, state, and national codes
2. The National Electric Code (NEC)

3. The National Electrical Safety Code (NESC)
4. Electronic Industries Association (EIA) / Telecommunications Industry Association (TIA) ANSI/TIA-526-14-C, ANSI/TIA-568-C, ANSI/TIA-569-C, ANSI/TIA-598-D, ANSI/TIA-606- B, ANSI/TIA-607-B, ANSI/TIA-758-B and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 STRUCTURED CABLING SYSTEM

A. The entire voice copper backbone cabling solution shall be a listed EIA/TIA cabling system solution from a single Manufacturer/Source as required by the Manufacturer/Source. Provide a listed “tuned” cabling system solution utilizing cable/components.

B. Indoor backbone cabling shall be non-plenum rated.

C. Outdoor and underground backbone cabling shall be OSP rated.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Backboard mounted wiring connecting blocks shall be mounted such that the top of block is no more than 72 inches from the floor and the bottom of lowest block is no lower than 30 inches from the floor.

B. Cross connects / patch cables from voice backbone cable to voice station cables shall be provided by this Contractor.

C. Refer to drawings for quantity and arrangement of voice/data backbone cabling system.

D. Make all voice and data backbone terminations at TR termination equipment at each end utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

E. Coordinate all cable and termination equipment color requirements with Owner / Engineer. Color coding shall be consistent for all like equipment.

F. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.02 WIRING INSTALLATION

A. Backbone cabling shall not exceed the EIA/TIA maximum lengths for the specified Category rating. The contractor shall be responsible for verifying adequate cable pathways to limit cable lengths prior to installation. Where existing or designed pathways do not allow for compliance to distance

limitations for backbone cabling, the contractor shall provide alternate pathway routes to the Engineer for review.

B. Backbone multi-pair copper shall maintain a 10X cable diameter bending radius during cable pull.

C. Interior - All cables shall be run in conduit/cable tray/cable management system between communications equipment rooms as indicated on drawings and specifications. All cabling shall be run parallel or perpendicular to building lines.

D. Exterior – all cables shall be run in duct bank system as shown on drawings.

E. The drawings do not indicate specific or complete routes for telecommunications cables. The Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adheres to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

F. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system. Cable management system shall provide support no more than 5 ft. on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 feet of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1. Motors and transformers – 48 inches
2. Conduit and cable used for electrical power distribution – 12 inches
3. Fluorescent lighting – 5 inches
4. Power lines up to 2kVA – 5 inches
5. Power lines over 5kVA – 24 inches
6. Hot water/steam lines - Bare –18 inches, Insulated – 6 inches

G. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

H. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed, or otherwise deformed when installed within

component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

I. Data backbone cables shall be handled and installed with extreme care. Twisted pairs shall be untwisted less than .5 inch at terminations for Cat, 5e, Cat. 6. Tie wraps shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 4 times the outer diameter of the cable. The cable manufacturer's recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

J. Provide adequate cable slack at each Communications Equipment Room termination equipment as follows:

1. Data Backbone – Provide adequate slack to move the data termination equipment a minimum of 10 feet in any direction.
2. Voice Backbone – Provide adequate slack to move the voice termination equipment a minimum of 10 feet in any direction.

K. Where cables are installed in conduit, the conduit system shall conform to the following:

1. No section of conduit shall be longer than 100 feet between pulling points.
2. No more than two 90 deg. Bends in a section of conduit between pulling points.
3. Each section of conduit shall be labeled for length, destination closet and origination closet.
4. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

L. At voice termination equipment at TR racks/backboards, voice backbone cables shall be terminated following the standard telephone color code unless otherwise indicated.

M. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

3.03 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

3.04 IDENTIFICATION/LABELING

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. Each cable, jack cross-connect, and patch panel shall be labeled at every location where they are administered per TIA/EIA-606.

C. Backbone cable shall be identified and labeled on the blocks and patch panels. Both ends of data and telephone system cabling shall be tagged and identified utilizing a permanent cable marking system or other system as approved by the Owner / Engineer. DYMO style labels, cloth or plastic “numbers” or handwritten labels WILL NOT BE ACCEPTED.

D. The contractor shall be responsible for the numbering scheme as directed by the Owner.

E. Create a detailed record sheet for each backbone cable. Record shall indicate connection rack / backboard, patch panel / cross-connect and jack / port, at both ends, for each cable within each backbone cable assembly. Provide with O&M Manual

F. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.05 TESTING GENERAL

A. The Contractor shall be responsible for testing all installed Structured cables including:

1. Data backbone

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.

C. The Contractor shall be responsible for testing all backbone cables.

D. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

E. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

F. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed, and the system will not be commissioned by the Owner / Architect / Engineer.

G. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

H. The Owner / Architect / Engineer reserves the right to spot test 5 percent of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined that the installed cable plant does not agree with the documented test results, the contractor shall

be responsible for re-testing the installed voice/data/fiber cabling plant and revising / updating all test documentation as required.

I. Instruments required for tests shall be furnished by the Contractor.

3.06 TESTING VOICE BACKBONE

A. Each user data backbone cable system shall be electronically verified. The respondent's test plan will specify the procedures for the following tests:
   1. Wire Map - A continuity test to determine correct pin-out at each end. The test inherently verifies correct circuit identification.
   2. Length - Each cable pair is TDR scanned to determine each pair's individual length. The test results are recorded in feet.
   3. DC Resistance
   4. Mutual Capacitance
   5. Capacitance Unbalance: Pair-to-ground
   6. Characteristic Impedance
   7. Structural Return Loss
   8. Insertion Loss

B. Provide a hard copy of the test results of each and every voice and data channel tested to the Owner. Documentation shall be in the following format:
   1. Cable ID
   2. Date of test
   3. Length
   4. Pass / Fail result
   5. Provide an electronic copy of the LINK/CHANNEL testing done with a cable analyzer and saved on CD Rom. Test results saved in a proprietary file type shall be included with software for reading the test results on the Owner’s computer system. Test results shall be verified by the Owner as part of the acceptance procedure. Provide with hard copies and a CD containing the electronic files with the O&M Manuals.

3.07 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor’s expense prior to system acceptance.

3.08 AS-BUILT DOCUMENTATION

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer's stamp.

C. 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.

1. AutoCAD architectural floor plans at a scale of 0.125 inch =1 foot-0 inches on 30x42 size sheets showing the routing of all backbone cables between communications equipment rooms. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.

2. 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.

3. Rack and wall elevations for all backbone cable termination systems. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such as patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.

D. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by type (data, voice) and by closet. Information must be included in O&M Manuals.

E. Create a detailed record sheet for each backbone cable. Record shall indicate connection rack / backboard, patch panel / cross-connect and jack / port, at both ends, for each cable within each backbone cable assembly. Provide with O&M Manual.

F. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.09 WARRANTY

A. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer, and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.10 CERTIFICATION

A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.

END OF SECTION

27.13.23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings.

Work shall consist of:

1. Backbone cabling between the MDF and each IDF including termination, testing and labeling. Four cables shall be homerun from each IDF to the MDF.

1.02 QUALITY ASSURANCE

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, ANSI, ICEA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.03 CONTRACTOR QUALIFICATIONS

A. Work shall be performed by a BICSI certified Telecommunications Contractor that is properly certified in the cabling system being installed. Contractor's requesting pre-approval from the Engineer to perform the work as specified in this section shall meet the following requirements:

1. The Contractor must have an on-staff, full time RCDD. The personnel assigned to project manager for this project must be a current RCDD in good standing.
2. The personnel assigned to project foreman at the project site must be a minimum BICSI Level II certified installer.
3. The Contractor must have at least one BICSI Level I certified installer in the daily work crew.

B. The Contractor must hold a current certification from the manufacturer of the proposed cabling system solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer's product and applications warranties as specified herein.

C. Requests for consideration shall be sent to the Construction Manager/Architect/Engineer (by mail or fax) and shall include the following:

1. Copy of the BICSI RCDD certificate for the Contractor's on-staff, full time project manager.
2. Copy of the BICSI Level I, II and III certificate(s) for the Contractor's on-staff, full time installation personnel. Prior to commencement of work, the Contractor shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be based

upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.

3. Copy of the Data System Manufacturers Approval Certificate indicating that the Contractor is a certified installer of the proposed data Cabling System Solution.
4. It will not be the responsibility of the Engineer to recognize or respond to incomplete or incorrect requests.

D. It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Engineer in writing. Refer to following requirements:

1. The Engineer will respond in writing to applicants who meet the requirements of this specification or to the project's construction manager. This response will serve as formal notice that the Contractor is approved for the listed project.
2. Contractors who have not received approval from the Engineer prior to issue of formal contracts will not be approved to perform the work outlined in this specification section regardless of their qualifications.

1.04 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Qualifications

1. Copy of current BICSI and manufacturers certifications. Certifications that are past the expiration date will not be accepted.
2. A statement of contractor's qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

1.05 RELEVANT STANDARDS

A. The Structured Cabling Installation shall comply with the following at a minimum:

1. All local, state and national codes.
2. The National Electric Code (NEC),
3. The National Electrical Safety Code (NESC).
4. Electronic Industries Alliance (EIA)/ Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.01 STRUCTURED CABLING SYSTEM

A. The entire data vertical fiber optic backbone cabling solution shall be a listed EIA/TIA cabling system solution from a single Manufacturer/Source as required by the Manufacturer/Source. Provide a listed Cabling System Solution utilizing cable/components from the following list of acceptable manufacturers:

1. 1. Cable – Corning.
2. 2. Components – Corning

B. Indoor backbone cabling shall be indoor armored non-plenum rated. Data Backbone Cable – Fiber

C. Indoor type - shall be a tight buffered, break out style cable armored distribution, dielectric strength members, 2.9 mm flexible sub-units for each fiber strand. Sub-units shall consist of minimum 2.0 mm tube, dielectric strength members and 900 um buffered fiber.

1. Single mode (low water peak)
2. Core/Cladding diameter 8.3/1.0 um
3. Maximum attenuation @ 1300/1550 nm 1.0/0.75 dB/km
4. Support of IEEE 802.3z 5000m
5. Maximum dispersion (1300 nm) <3.2 ps/nm*km
6. Maximum dispersion (1550 nm) <18 ps/nm*km

D. Cable shall be terminated on both ends as specified herein. Utilize appropriate break-out kit.

E. Provide a 3-meter Figure 8 maintenance loop at the termination point. Consult the cable manufacturer for the recommended loop radius.

F. Cable shall be labeled on both ends and at all accessible points where the cable can be administered. Coordinate labeling scheme with Owner and submit to Engineer for review.

G. All fiber leaving the data center shall be run in conduit and/or shall be armored.

H. Refer to the drawings for quantities and locations.

I. This cable type shall NOT be used in underground conduit installations.

2.02 COMMUNICATIONS EQUIPMENT ROOM TERMINATION EQUIPMENT

A. Rack and Cabinet Mounted Installation - Provide fiber optic, rack mounted patch panels with

type LC duplex coupler panels as coordinated with the Owner. Provide quantity of 24 or 48 port panels as required by quantity of fiber station cables to be terminated. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Mount panels in

equipment racks/cabinets as indicated on drawings. Each connected port to be labeled as coordinated with Owner. Refer to drawings for locations of rack mounted patch panels.

B. Provide quantity of fiber patch panels to accommodate complete termination of all installed fiber backbone strands.

C. All fiber strands run between buildings to be terminated on fusion spliced, factory polished pigtails. Fusion splice shall be core-alignment type.

2.03 INNERDUCT

A. Interior Innerduct – UL listed, plenum rated, flexible innerduct, corrugated with pull line. All interior fiber optic cables shall be installed in innerduct.

2.04 PATCH CABLES

A. This contract shall be responsible for providing all required patch cables to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications:

1. Data Backbone - Provide three (3) 2-meter 2 strand fiber jumper cables at each termination point for each fiber backbone cable. Coordinate jumper type and length with Owner.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Refer to drawings for quantity and arrangement of backbone cabling system.

B. Make all backbone terminations at TR termination equipment at each end utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

C. Coordinate all cable and termination equipment color requirements with Owner / Engineer. Color coding shall be consistent for all like equipment.

D. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.02 WIRING INSTALLATION

A. Backbone cabling shall not exceed the maximum lengths for the specified rating. The contractor shall be responsible for verifying adequate cable pathways to limit cable lengths prior to installation. Where existing or designed pathways do not allow for compliance to distance limitations for backbone cabling, the contractor shall provide alternate pathway routes to the Engineer for review.

B. Interior - All cables shall be run in cable basket tray system between Communications Equipment Racks as indicated on drawings and specifications. All cabling shall be run parallel or perpendicular to building lines

C. Exterior – all cables shall be run in duct bank system as shown on drawings.

D. The drawings do not indicate specific or complete routes for telecommunications cables. The Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adheres to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work

E. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a Cable Management System. Cable management system shall provide support no more than 5 feet on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1. Motors and transformers – 48 inches
2. Conduit and cable used for electrical power distribution – 12 inches
3. Fluorescent lighting – 5 inches
4. Power lines up to 2kVA – 5 inches
5. Power lines over 5kVA – 24 inches
6. Hot water/steam lines - Bare –18 inches, Insulated – 6 inches

F. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

G. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed, or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

H. Data backbone cables shall be handled and installed with extreme care. Tie wraps shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 10 times the outer diameter of the cable. The cable manufacturer's recommended bending radius and maximum pulling tensions shall be strictly

adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

I. Provide adequate cable slack at each Communications Equipment Room termination equipment as follows:
    1. Provide adequate slack to move the data termination equipment a minimum of 10 feet in any direction.

J. Where cables are installed in conduit, the conduit system shall conform to the following:
    1. No section of conduit shall be longer than 100 feet between pulling points.
    2. No more than two 90 deg. Bends in a section of conduit between pulling points.
    3. Each section of conduit shall be labeled for length, destination closet and origination closet.
    4. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

K. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

3.03 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

3.04 PROGRAMMING – Not Applicable

3.05 IDENTIFICATION/LABELING

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. Each cable, jack cross-connect, and patch panel shall be labeled at every location where they are administered per TIA/EIA-606

C. Backbone cable shall be identified and labeled on the blocks and patch panels. Both ends of data and telephone system cabling shall be tagged and identified utilizing a permanent cable marking system or other system as approved by the Owner / Engineer. DYMO style labels, cloth or plastic “numbers” or handwritten labels WILL NOT BE ACCEPTED.

D. Sample label for a backbone cable / jack / punch block, BF-03-5 (read as: Backbone cable, fiber optic type - cable number three of the group of fiber optic backbone cable - terminating in IDF 5).
    1. The first syllable shall consist of two (2) letters. The first letter shall be “B” indicating “Backbone cable”. The second letter shall indicate cable type (“T” - Telephone, “F” - Fiber).
    2. The second syllable shall consist of a numeral indicating the specific cable within that group of cable types. Each backbone cable type shall be grouped and numbered consecutively.
    3. The third syllable shall consist of a numeral indicating the designation wiring closet “IDF” (IDF 2 would be “2”, IDF 7 would be “7”, etc.) the cable is terminated in.
E. Data patch panels must provide corresponding numbering.
F. On renovation projects where there already exists a numbering scheme, this contractor shall be responsible for maintaining and extending that numbering scheme as directed by the Owner.
G. Create a detailed record sheet for each backbone cable. Record shall indicate connection rack / backboard, patch panel / cross-connect and jack / port, at both ends, for each cable within each backbone cable assembly. Provide with O&M Manual.
H. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.06 TESTING GENERAL

A. The Contractor shall be responsible for testing all installed structured cables.
B. The Contractor shall submit a written fiber test plan to the Engineer for review. The test plan shall include the following
    1. Make/Model of testers being utilized for power meter and OTDR tests.
    2. Launch cable length/attenuation for SM and MM.
    3. Automatic or manual settings for length/pulse/time. If manual, indicate how the settings will be determined.
C. Pass/fail criteria for Power Meter Tests.
D. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.
E. The Contractor shall be responsible for testing all fiber backbone cable strands with both OTDR bi-directional and power meter. The OTDR results shall be submitted in digital format (trace files) along with required viewer software. The power meter tests shall be submitted in digital format directly as saved from the test equipment along with software viewer.

F. The contractor shall provide independent 3rd party testing of 10 percent of all installed data outlets. This independent testing shall be assembled in a separate binder and submitted along with the test reports in the O&M manual. Significant discrepancies in test results between the independent testing and the Contractor's testing shall be addressed by the Contractor to the Engineer and the Owner's satisfaction.

G. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

H. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

I. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed, and the system will not be commissioned by the Owner / Architect / Engineer.

J. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application

K. The Owner / Architect / Engineer reserves the right to spot test 5 percent of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined that the installed cable plant does not agree with the documented test results, the contractor shall be responsible for re-testing the installed data/fiber cabling plant and revising/updating all test documentation as required.

L. Instruments required for tests shall be furnished by the Contractor.

3.7 TESTING DATA BACKBONE FIBER

A. Multi-mode - Provide an end-to-end attenuation test at 850 nm and 1300 nm for all multi-mode fiber links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-14; "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant". Provide a hard copy of the test results to the Owner. Launch cable shall be a minimum of 300 meters for OTDR tests. In lieu of bi-directional testing, the Contractor may utilize a receive cable of sufficient length to allow accurate readings of the final end connector pair.

B. Single-mode - Provide an end-to-end attenuation test at 1310 nm and 1550 nm for all single mode fiber optic cable links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-7; "Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant". Provide a hard copy of the test results to the Owner. Launch cable shall be a minimum of 500 meters for OTDR tests. In lieu of bi-directional testing, the Contractor may utilize a receive cable of sufficient length to allow accurate readings of the final end connector pair.

C. Fiber cables shall be pre-tested for length and OTDR on the spool prior to installation. A variance of more than 3dB from the Manufacturer's OTDR or a length discrepancy of more than 10 percent shall be reported to the Owner.

D. Each optical fiber cable strand and jack shall be electronically verified based upon the following criteria

1. Continuity Test
2. Insertion Loss Test
3. Return Loss Test
4. Optical Time Domain Reflectometer (OTDR) (EIA/TIA – TSB140)
5. Bandwidth Certification or Link Confidence Testing (LCT)
6. The raw information which is generated from these test methods will be compiled, organized, and presented as an indication of the installed fiber optic network's compliance to specifications and overall quality. These test results shall be included in the O&M manuals.

E. The fiber plant shall be certified to meet the following performance criteria:

1. SM insertion loss < 0.3 dB
2. SM ORL < -26 dB
3. MM insertion loss < 0.5 dB
4. MM ORL < -20 dB

3.08 TESTING DATA BACKBONE PRE-TERMINATED FIBER

A. Single-mode - Provide an end-to-end attenuation test at 1310 nm and 1550 nm for all singlemode fiber optic cable links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-7; "Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant". Provide a hard copy of the test results to the Owner.

B. Each optical fiber cable strand and jack shall be electronically verified based upon the following criteria:

1. Continuity Test
2. Insertion Loss Test
3. Return Loss Test
4. Bandwidth Certification or Link Confidence Testing (LCT)
5. The raw information which is generated from these test methods will be compiled, organized and presented as an indication of the installed fiber optic network's compliance to specifications and overall quality. These test results shall be included in the O&M manuals.

C. The fiber plant shall be certified to meet the following performance criteria:
    1. SM insertion loss < 0.3 dB
    2. SM ORL < -26 dB
    3. MM insertion loss < 0.5 dB
    4. MM ORL < -20 dB

3.09 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor's expense prior to system acceptance.

3.10 AS-BUILT DOCUMENTATION

A. Copies of all approved shop drawings with the Engineer's stamp.

B. 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 digital media with electronic versions of Owner's manuals. Digital media containing electronic versions of Owner's manuals must contain the proper software viewers for each document type. This includes all termination cabinets, panels and enclosures.

C. 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.
    1. 1. AutoCAD architectural floor plans at a scale of 0.125 inch=1 foot-0 inches on 30x42, 24x36 size sheets showing the routing of all backbone cables between communications equipment rooms. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.
    2. 2. 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.
    3. 3. Rack elevations for all systems with rack mounted equipment. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such

as patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.

D. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by media (fiber, copper) and by closet. Information must be included in O&M Manuals.

1. Fiber Test Results - The raw information which is generated from these test methods will be compiled, organized and presented as an indication of the installed fiber optic network's compliance to specifications and overall quality. These test results shall be included in the O&M manuals.
2. Multi-mode Fiber test results - Provide an end-to-end attenuation test at 850 nm and 1300 nm for all multi-mode fiber links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-14; "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant". Provide a hard copy of the test results to the Owner. Each optical fiber cable and jack shall be electronically verified based upon the following criteria:
   i. Continuity Test
   ii. Insertion Loss Test
   iii. Return Loss Test
   iv. Optical Time Domain Reflectometer (OTDR)
   v. Bandwidth Certification or Link Confidence Testing (LCT)
3. Single-mode Fiber test results - Provide an end-to-end attenuation test at 1310 nm and 1550 nm for all single-mode fiber optic cable links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-7; "Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant". Provide a hard copy of the test results to the Owner. Each optical fiber cable and jack shall be electronically verified based upon the following criteria:
   i. Continuity Test
   ii. Insertion Loss Test
   iii. Return Loss Test
   iv. Optical Time Domain Reflectometer (OTDR)
   v. Bandwidth Certification or Link Confidence Testing (LCT)

E. Create a detailed record sheet for each backbone cable. Record shall indicate connection rack

/ backboard, patch panel / cross-connect and jack / port, at both ends, for each cable within each backbone cable assembly. Provide with O&M Manual.

F. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.11 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

3.12 CERTIFICATION

A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.

B. Project final completion will be pending delivery of manufacturer’s warranty certificate.

END OF SECTION

27.21.33 - DATA COMMUNICATIONS WIRELESS ACCESS POINTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All provisions of the Division 00 and Division 01, apply to all work in Division 27.

1.2 SCOPE OF WORK

A. This specification section is intended to provide a complete system Wireless Local Area Network Electronics (WLAN) system as indicated herein and as shown on the contract documents.

B. Provide an IEEE 802.11ax wave 2 standard and WiFi compliant system of wireless access points (AP), antennas (interior and exterior), Plenum rated AP housings, cabling, RF Management platforms, RF site survey, Mobil Device Management (MDM), Application management, programming, and testing as required to provide a complete and comprehensive WLAN within the specified areas.

C. The WLAN shall provide support for 4:1 ratio with adequate client support as well as total system throughput:

   a. 7Mbps per attached user minimum with the ability to control throughput on a per user level

   b. Provide minimum of -65dB signal level at all locations in building for 802.11ax coverage.

   c. Provide capacity coverage of 30-90 devices per radio

   d. Provide capacity coverage for 30 people per room

D. Programming of each AP to coordinate with the Owner's LAN Network Operating System and mobile wireless client device configuration and requirements including establishing parameters and operations associated with security, QoS, CoS, VLANs, etc.

E. Provide and install all labor, tools material and accessories for a complete Data Network WAN comprised of components as listed in Part 2.

F. This contractor is responsible for supplying the proper configuration to OWNER with quantities and model numbers for a complete working system.

G. Perform an RF Survey Utilizing a Wi-Fi Survey software tool to verify coverage. Contractor shall provide a written survey report to the Owner technical staff prior to installation. Contractor shall provide an electronic copy of the Project file with the written report.

H. Owner may opt to have third party site survey verification of the wireless coverage provided by Contractor.

I. The Contractor shall demonstrate to the Owner and Engineer that the system is complete and complies with all operational requirements set forth in the plans and specs. The contractor shall

provide all miscellaneous items and accessories required to make the system operational whether or not such items are specifically mentions in the plans and specifications.

J. The contractor shall review all plans and specifications for any detail that may impact the installation of the system. Any discrepancies discovered shall be brought to the attention or the engineer prior to installation.

1.03 SYSTEM DESCRIPTION

A. The WLAN system shall be an 802.11ax standard and WiFi standard compliant and shall conform to the following minimum requirements:
   a. WPA2-AES compliant, WPA3 upgradable with 192-bit encryption
   b. Fully WiFi6 and WiFi5 Compliant, including full MU-MIMO, downlink, and uplink OFDMA.
   c. BLE 5
   d. Advanced Cellular Coexistence
   e. VoWiFi compliant
   f. Comply with all appropriate FCC regulations. This shall be deemed to include the equipment as well as the installation.
   g. Provide ubiquitous coverage throughout the facility regardless of frequency band.
   h. Utilize POE+ IEEE 802.3at standards for access points.

B. Provide a system of RF management with features such as Intrusion Detection, seamless Layer 3 roaming, load balancing, self-healing, etc. The WLAN system shall provide real-time awareness and location of all authorized access points and shall provide means and methods to isolate and remove rogue access points automatically.

C. The WLAN system shall provide intelligent management with such features as support for VLANs and 802.11e QoS features to ensure highest priority to the most sensitive data (such as VoIP and video conferencing).

D. Patch cables to connect the WLAN AP to the LAN electronics are provided under section 27.21.00. This contract shall be responsible for connection of cable to AP and coordination of exact AP locations with 27.15.13 contractors.

E. The wireless network and all its components shall be installed so that access is provided to all components for general maintenance and repair.

F. The wireless network equipment shall connect to various types of new or existing equipment.
   a. The contractor shall provide and configure all the equipment required for connecting the wireless network to the local area network.

b. The Contractor shall ensure the wireless network is compatible with any routers, gateways, firewall etc. provided by others.

G. The contractor shall be responsible for working with the owner, owner's representative or other contractors for the final layout and configuration of the wireless network. This shall include but not be limited to all aspects of Security, VLANS, traffic shaping, IP addressing, integration with servers, DHCP address assignments, traffic prioritization, routing and all other aspects of the configuration of the data electronics.

1.04 QUALITY ASSURANCE

A. The Contractor shall maintain a fully equipped factory certified service organization which under normal business operations will provide full maintenance and service of the installed system within 24 hours.

B. The equipment supplier shall have been an authorized distributor of the equipment provided for a minimum of 1 year. The equipment supplier shall provide factory trained technicians for programming, installation support and training of Owner personnel.

C. All components of the system shall be newly manufactured products. Remanufactured, refurbished or show floor equipment is not permissible.

D. The system shall be installed with the latest revision of all hardware, firmware and software supported by the manufacturer, as of the date of the solution implementation.

E. All equipment shall be UL listed.

F. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.

G. All equipment Installation Practices shall comply with the Local Electric Code.

H. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.

I. All equipment and Installation Practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM).

J. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.

K. All equipment shall provide protection and containment of unwanted wireless signals and prevent people access to unwanted networks and content, in accordance with CIPA requirements.

L. FCC/Industry of Canada

M. CE Marked

N. R&TTE Directive 1995/5/EC

O. Low Voltage Directive 72/23/EEC

P. EN 300 328

Q. EN 301 489

R. EN 301 893

S. UL/IEC/EN 60950

T. EN 60601-1-1, EN60601-1-2

U. CB Scheme Safety, cTUVus

V. UL2043 plenum rating

W. Wi-Fi Alliance certified 802.11a/b/g/n/ac

1.05 CONTRACTOR QUALIFICATIONS

A. The Network Electronics system shall be furnished, installed, and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the contractor to utilize a sub-contractor for any portion of the work, unless the subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified Network Electronics. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The contractor shall provide references and contract information for the project sites in which the qualifying installations occurred.

1.06 SHOP DRAWINGS AND SUBMITTALS

A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30” x 42” paper. Equipment lists, data sheets, etc. Shall be 8-1/2” x 11” size properly stored on digital media.

B. Submit to the following for approval:

   a. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.

   b. Manufacturer's data sheets on all equipment items.

   c. System block diagram(s)

   d. Equipment rack layouts showing all rack mounted equipment items.

e. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

1.07 FINAL DOCUMENTATION

A. All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner, four (4) sets of the following:

B. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers, and quantities of each item.

C. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and coding.

D. Complete equipment rack layouts showing all rack mounted equipment items.

E. Operations instructions for each major item of equipment furnished.

F. Manufacturer's warranty for each major item of equipment furnished.

G. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner’s operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.08 COORDINATION

A. Coordinate the location of the data network electronics and racks with the Electrical Contractor for placement of electrical connections.

B. Coordinate the configuration of the data network electronics for compatibility with WAN connections, addressing and routing.

C. Coordinate UPS and Power Strip locations with other trades for placement of electrical connections.

D. Coordinate all UPS and Power Strip input connectors with electrical contractor.

E. Coordinate with the Network Integrators such that the UPS units are communicating with the network utilizing their SNMP cards or IP based web monitoring.

1.09 STORAGE OF MATERIALS

A. All materials shall be secured when not in use by the Contractor.

B. It shall be the Contractor's responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.10 SYSTEM WARRANTY

A. The Wireless Area Network Electronics software shall be warranted by the contractor for a period of three (3) years from date of substantial completion.

B. Provide advanced replacement for all Network Electronics for the three (3) year period.

C. Provide proof of warranty from manufacturer.

1.11 RELATED WORK BY OTHERS

A. All conduit with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.

B. All power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The power to the equipment racks shall be terminated inside the racks to Contractor - supplied isolated ground plug strips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.

C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground.

PART 2 - PRODUCTS

2.01 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the “precise functional equivalent” shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.02 WIRELESS NETWORK--GENERAL

A. Provide all necessary licenses required for a fully operational system.

B. Provide Centrally Powered, 802.11ax Wi-Fi AP with 2.5Gbps NBASE-T uplink Wireless Access Points and associated Wireless Network Controller(s) or cloud-based controller, to support wireless Network Devices and Phones throughout the building and the associated campus.

C. Shall have the ability to manage the AP directly

D. Dual radios shall support 2.4GHz: 575Mbps (11ax) and 5GHz: 4.8 Gbps (11ax)

E. Coordinate 802.1X, VLAN and Security Settings/Requirements with the Owner.

F. Provide ubiquitous wireless coverage for the entire building and associated perimeter area based on capacity (assumption of 2 devices per individual).

G. Provide minimum of:

   a. 3:1 ratio of devices per person

   b. -65 dB signal level throughout building for ubiquitous 802.11ax coverage.

   c. 7 Mbps throughput per user with the ability to control throughput on a per user level

   d. 30-90 devices per AP/radio

H. Supply sufficient Access Points to provide for expected throughput and load sharing.

I. The users shall “see” at least 3 Access points to provide for load sharing and balancing.

J. Wireless Survey

   a. Prior to installation of cabling for Access Points, the contractor shall perform an on-site Validation Survey. This survey shall be utilized to obtain actual site conditions including RF environment and RF properties of the construction. Prepare an AP placement plan utilizing the Validation Survey information and using the AP controllers “planning” tools. Provide a report to the Owner and Technology Consultant for review and approval.

   b. After complete install of all AP’s, perform a final survey to verify coverage. Move any AP’s required to guarantee that coverage and performance requirements are met. Provide final report to the Owner and Technology Consultant for review and approval.

K. Coordinate with local Law Enforcement and Safety Forces regarding their requirements for remote and wireless access into building Security and Energy Management Systems.

L. Law Enforcement and Safety Forces shall be responsible for providing their own remote access equipment.

2.03 WIRELESS CONTROLLER or WIRELESS SOFTWARE FOR CLOUD MANAGED

A. Scalability and performance

   a. 1024 access points

   b. 24,000 clients

   c. 4096 VLANs

B. RF management
    a. Proactively identifies and mitigates signal interference for better performance
    b. Provides both real-time and historical information about RF interference affecting network performance across controllers, through system wide integration
C. Multimode with indoor, outdoor mesh access points
    a. Controller with support for centralized, distributed, and mesh deployments to be used at different places in the network
    b. Centralized control, management, and client troubleshooting
    c. Seamless client access in the event of a WAN link failure (local data switching)
    d. Access point upgrade optimizes the WAN link utilization for downloading access point images
    e. Technology that supports corporate wireless service for mobile and remote workers with secure wired tunnels to indoor access points
D. Security
    a. Client data should be securely encrypted and tunneled from APs to Controller
    b. Management frame protection detects malicious users and alerts network administrators
    c. Rogue access point detection and detection of denial-of-service attacks
E. Voice Support
    a. Supports Unified Communications for improved collaboration through messaging, presence, and conferencing
    b. Supports all Unified IP Phones for cost-effective, real-time voice services
F. Fault tolerance and high availability
    a. Sub-second access point and client failover for uninterrupted application availability
    b. Multi 1 Gigabit or NBASE-T Ethernet connectivity
    c. Solid-state device-based storage – no moving parts
    d. Hot-swappable redundant AC or DC power supply and solid-state storage with no incremental system downtime
G. Service provider Wi-Fi
    a. Wi-Fi Alliance Passpoint (Hotspot 2.0) certified, facilitating hotspot operation for mobile data offloads
    b. Network-based mobility management
H. Enterprise Wireless Mesh

a. Enterprise Wireless Mesh is ideal for locations where extending a wired connection may prove difficult or aesthetically unappealing: parking lots, playgrounds, stadiums, campus environments

I. Mobility, security, and management for IPv6 and dual-stack clients

a. Highly secure, reliable wireless connectivity and consistent end-user experience

b. Increased network availability through proactive blocking of known threats

J. Licensing

a. Provide right-to-use (with End-User License Agreement [EULA] acceptance) license enablement for faster time to deployment, with flexibility to add additional access points as business needs grow.

b. Additional access point capacity licenses can be added over time.

c. Right-to-use licensing (with EULA acceptance) for faster and easier license enablement.

K. Wireless

a. IEEE 802.11a, 802.11b, 802.11g, 802.11d, WMM/802.11e, 802.11h, 802.11n, 802.11k, 802.11r, 802.11u, 802.11w, 802.11ax Wave1 and Wave2, 802.11ax

L. Data request for comments (RFC)

a. RFC 768 UDP

b. RFC 791 IP

c. RFC 2460 IPv6

d. RFC 792 ICMP

e. RFC 793 TCP

f. RFC 826 ARP

g. RFC 1122 Requirements for Internet Hosts

h. RFC 1519 CIDR

i. RFC 1542 BOOTP

j. RFC 2131 DHCP

M. Security standards

a. Wi-Fi Protected Access 2 and 3 (WPA2, WPA3)

b. IEEE 802.11i (WPA2, RSN)

c. RFC 1321 MD5 Message-Digest Algorithm

d. RFC 1851 ESP Triple DES Transform

e. RFC 2104 HMAC: Keyed Hashing for Message Authentication

f. RFC 2246 TLS Protocol Version 1.0

g. RFC 2401 Security Architecture for the Internet Protocol

h. RFC 2403 HMAC-MD5-96 within ESP and AH

i. RFC 2404 HMAC-SHA-1-96 within ESP and AH

j. RFC 2405 ESP DES-CBC Cipher Algorithm with Explicit IV

k. RFC 2407 Interpretation for ISAKMP

l. RFC 2408 ISAKMP

m. RFC 2409 IKE

n. RFC 2451 ESP CBC-Mode Cipher Algorithms

o. RFC 3280 Internet X.509 PKI Certificate and CRL Profile

p. RFC 4347 Datagram Transport Layer Security

q. RFC 4346 TLS Protocol Version 1.1

N. Encryption

a. Wired Equivalent Privacy (WEP) and Temporal Key Integrity Protocol-Message Integrity Check (TKIP-MIC): RC4 40, 104 and 128 bits (both static and shared keys)

b. Advanced Encryption Standard (AES): Cipher Block Chaining (CBC), Counter with CBC-MAC (CCM), Counter with Cipher Block Chaining Message Authentication Code Protocol (CCMP)

c. Data Encryption Standard (DES): DES-CBC, 3DES

d. Secure Sockets Layer (SSL) and Transport Layer Security (TLS): RC4 128-bit and RSA 1024- and 2048-bit

e. DTLS: AES-CBC

f. IPsec: DES-CBC, 3DES, AES-CBC

g. 802.1AE MACsec encryption

O. Authentication, authorization, and accounting (AAA)

a. IEEE 802.1X

b. RFC 2548 Microsoft Vendor-Specific RADIUS Attributes

c. RFC 2716 PPP EAP-TLS

d. RFC 2865 RADIUS Authentication

e. RFC 2866 RADIUS Accounting

f. RFC 2867 RADIUS Tunnel Accounting

g. RFC 3576 Dynamic Authorization Extensions to RADIUS

h. RFC 3579 RADIUS Support for EAP

i. RFC 3580 IEEE 802.1X RADIUS Guidelines

j. RFC 3748 Extensible Authentication Protocol (EAP)

k. Web-based authentication

l. TACACS support for management users

P. Management

a. Simple Network Management Protocol (SNMP) v1, v2c, v3

b. RFC 854 Telnet

c. RFC 1155 Management Information for TCP/IP-Based Internets

d. RFC 1156 MIB

e. RFC 1157 SNMP

f. RFC 1213 SNMP MIB II

g. RFC 1350 TFTP

h. RFC 1643 Ethernet MIB

i. RFC 2030 SNTP

j. RFC 2616 HTTP

k. RFC 2665 Ethernet-Like Interface types MIB

l. RFC 2674 Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and Virtual Extensions

m. RFC 2819 RMON MIB

n. RFC 2863 Interfaces Group MIB

o. RFC 3164 Syslog

p. RFC 3414 User-Based Security Model (USM) for SNMPv3

q. RFC 3418 MIB for SNMP

r. RFC 3636 Definitions of Managed Objects for IEEE 802.3 MAUs

Q. Management Interfaces

a. Web-based: HTTP/HTTPS

b. Command-line interface: Telnet, Secure Shell (SSH) Protocol, serial port

c. Cloud based or on-premise Network Management Software support

R. Interfaces and Indicators

a. 20Gb of uplink capacity minimum (2 x SFP+ or greater)

b. 1 x console port: Serial port (RJ-45 or USB)

c. LED indicators: Network Link, Diagnostics

S. Regulatory compliance

a. CE Markings per directives 2004/108/EC and 2006/95/EC Safety:

i. UL 60950-1 Second Edition

ii. CAN/CSA-C22.2 No. 60950-1 Second Edition

iii. EN 60950-1 Second Edition

iv. IEC 60950-1 Second Edition

v. AS/NZS 60950-1

vi. GB4943 2001

b. EMC - Emissions:

i. 47CFR Part 15 (CFR 47) Class A

ii. AS/NZS CISPR22 Class A

iii. EN55022 Class A

iv. ICES003 Class A VCCI Class A

v. EN61000-3-2 EN61000-3-3 KN22 Class A

vi. CNS13438 Class A

c. EMC - Immunity:

i. EN55024

ii. CISPR24

iii. EN300386

iv. KN24

T. Warranty three (3) year license with maintenance

2.04 WIRELESS ACCESS POINTS

A. Basis of Design: Aruba 515

B. The Owner requires a new wireless data network that will attach to the wired data network in the communications room. The system shall consist of wireless access points (AP) and management software.

C. The AP's shall be 802.11ax standard, WiFi compliant utilizing multi-band transceivers and shall conform to the following minimum specifications:

a. Indoor 802.11ax 4x4:4 Wi-Fi AP with 2.5Gbps Backhaul

b. Maximum PHY Rate

i. 2.4GHz: 575Mbps (11ax)
ii. 5GHz: 4.8 Gbps (11ax)

c. Wi-Fi Technology
d. Radio Chains: Streams
    i. 2.4GHz: 2x2:2
    ii. 5GHz: 4x4:4
e. Antenna Gain (Max) Up to 7.5dBi
f. USB
g. Ethernet Ports
    i. 1x 1/2.5/5 Gbps port (Nbase-T compliant, RJ-45
    ii. 1x 10/100/1000 Mbps port, RJ-45
    iii. Bluetooth 5 and Zigbee (802.15.4)

D. Changes to the AP's shall be able to be made globally from one interface.
E. The AP shall be able to be deployed across any Layer 2 or Layer 3 network and bridge traffic onto the local network, tunnel to a central location
F. AP shall be able to be deployed as a stand-a-lone AP or as part of a centrally managed wireless LAN
G. Each AP shall have at least two (2) Gigabit Ethernet ports for aggregated bandwidth
H. The wireless network access points shall be equipped with 802.11 a/b/g/n/ac/ax radios for multiple connectivity. Each access point shall meet the following specifications.
    a. Wi-Fi Standards
        i. IEEE 802.11a/b/g/n/ac/ax
    b. Supported Rates
        i. 802.11ax: 4 to 4800 Mbps
        ii. 802.11ac: 6.5 to 3467 Mbps
        iii. 802.11n: 6.5 to 600 Mbps
        iv. 802.11a/g: 6 to 54 Mbps
        v. 802.11b: 1 to 11 Mbps
    c. Supported Channels
        i. 2.4GHz: 1-13
        ii. 5GHz: 36-64, 100-144, 149-165
    d. MIMO

i. 4x4 MU-MIMO
ii. 4x4 SU-MIMO

e. Spatial Streams
i. 4 MU-MIMO
ii. 4 SU-MIMO

f. OFDMA
i. Uplink and Downlink

g. Channelization
i. 20, 40, 80, 160 MHz

h. Security
i. WPA-PSK, WPA-TKIP, WPA2 AES, 802.11i,
ii. WIPS/WIDS

i. Other Wi-Fi Features
i. WMM, Power Save, TxBF, LDPC, STBC, 802.11r/k/v

I. Networking
a. Mesh--Self-healing Mesh
b. IP--IPv4, IPv6
c. VLAN 802.1Q (16 BSSIDs / radio)
d. VLAN Pooling--Port-based, Dynamic, per user based on Radius
e. 802.1X--Wired & wireless Authenticator & Supplicant
f. Policy Management Tools
i. Application Visibility and Control
ii. Access Control Lists
iii. Device Fingerprinting

J. RF
a. Antenna Type (2.4GHz Antenna)
i. Omni: 2 Antennas
ii. Adaptive: 2 Antennas
b. Antenna Type (5GHz Antenna)
i. Omni: 4 Antennas
c. Antenna Gain (Max)

i. Up to 3.8dBi in 2.4GHz and 4.6dBi in 5GHz

d. Frequency Bands

i. 2.4 - 2.484 GHz

ii. 5.17 - 5.33 GHZ

iii. 5.49 - 5.71 GHz

iv. 5.735 - 5.835 GHz

K. The AP's shall provide for rapid traffic forwarding and capabilities that will enable effective real-time and air traffic-management through load balancing.

L. Traffic management shall be used to ensure maximum network uptime. Clients shall be routed around a failed access point to the closest available alternative on a real-time basis without manual intervention.

M. Each AP shall be able to support VoIP wireless phones and dynamically throttle back non-VoIP traffic.

N. Each AP shall have dual channels (2.4GHZ and 5 GHz) and conform to IEEE 802.11ax.

O. Integrated antennas

2.05 ANTENNAS

A. Provide each access point with the integral antennas based upon system configuration and site survey results. Utilize wall mounted antennas for exterior applications.

B. Exterior—Shall be rated for outdoor environment and shall be provided with lightning protection on the cabling. Provide drip loop on cabling entering the building. Both AP and antennas must be external and outdoor rated.

2.06 WIRELESS MANAGEMENT SOFTWARE

A. RF Management

a. In-band per Spectrum Analysis

b. Dynamic Channel Configuration

c. Dynamic Cell Size Configuration

d. Monitor radio for threat assessment and mitigation

e. Wired and Wireless Packet Captures (including all 802.11 headers)

f. Radio Assurance for radio self-test and healing

g. RF Monitor

B. High Availability Supports Hot Stand-by for mission critical areas

C. Supports ability to turn off radios based on schedule configuration or automatically when

not in use

D. Wireless Protocols:
   a. IEEE 802.11
   b. IEEE 802.11 a
   c. IEEE 802.11 b
   d. IEEE 802.11 d
   e. IEEE 802.11e
   f. IEEE 802.11 g
   g. IEEE 802.11h
   h. IEEE 802.11i
   i. IEEE.802.11 n
   j. IEEE 802.11ac
   k. IEEE 802.11ax

E. Wired Protocol
   a. IEEE 802.1p—Layer 2 Traffic Prioritization
   b. IEEE 802.1q—VLAN Tagging

F. RFC Support
   a. RFC 768 UDP
   b. RFC 791 IP
   c. RFC 2460 IPV6 (Bridging only)
   d. RFC 792 ICMP
   e. RFC 793 TCP
   f. RFC 1122 Requirements for Internet Hosts - Communication Layers
   g. RFC 1542 BOOTP
   h. RFC 2131 DHCP

G. Security
   a. IEEE 802.11i WPA2, RSN
   b. RFC 1321 MD5 Message-Digest Algorithm
   c. RFC 2246 TLS Protocol Version 1.0
   d. RFC 3280 Internet X.509 PKI Certificate and CRL Profile
   e. RFC 4347 Datagram Transport Layer Security

f. RFC 4346 TLS Protocol Version 1.1
g. WEP
h. WPA™ - Personal
i. WPA™ - Enterprise
j. WPA2™ - Personal
k. WPA2™ - Enterprise
l. EAP Type(s)
m. EAP-TLS
n. EAP-TTLS/MSCHAPv2
o. PEAPv0/EAP-MSCHAPv2
p. PEAPv1/EAP-GTC

H. Encryption Type
a. Open
b. WEP 64 and 128-bit
c. TKIP
d. CCMP/AES
e. SSL and TLS (RC4 128-bit, RSA 1024-bit, RSA 2048-bit)
f. L2TP/IPsec
g. PPTP (RFC 2637)

I. Authentication
a. IEEE 802.1X
b. RFC 2548 Microsoft Vendor-Specific RADIUS Attributes
c. RFC 2716 PPP EAP-TLS
d. RFC 2865 RADIUS Authentication
e. RFC 2866 RADIUS Accounting
f. RFC 2867 Tunnel Accounting
g. RFC 2869 RADIUS Extensions
h. RFC 3576 Dynamic Authorizations Extensions to RADIUS RFC 3579 RADIUS Support for EAP
i. RFC 3748 Extensible Authentication Protocol
j. Web Page Authentication

k. WPR, Landing Page, Redirect

l. Support for Internal WPR Landing Page and Authentication

m. Support for External WPR, Landing Page and Authentication

J. Channel Support 2.4GHz

a. 1 2 3 4 5 6 7 8 9 10 11

K. Channel Support 5GHz

a. Uni I - Non-DFS Channels

b. 36 40 44 48

c. UNI I DFS Channels

d. 52 56 60 64

e. UNI II DFS Channels

f. 100 104 108 112 116 120 124 128 132 136 140

g. UNI III Non-DFS Channels

h. 149 153 157 161 165

L. Management Interfaces

a. Command Line Interface via serial console, SSHv2, Telnet

b. Web Interface (http / https)

M. Management

a. SNMP v1, v2c, v3

b. RFC 854 Telnet

c. RFC 1155 Management Information for TCP/IP Based Internets

d. RFC 1156 MIB

e. RFC 1157 SNMP

f. RFC 1213 SNMP MIB II

g. RFC 1350 TFTP

h. RFC 1643 Ethernet MIB

i. RFC 2030 Simple Network Time Protocol SNTP

j. RFC 2616 HTTP 1.1

k. RFC 3636 Definitions of Managed Objects for IEEE

l. RFC 2674 Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions

m. RFC 2819 Remote Network Monitoring Management Information Base

n. RFC 2863 The Interface Group MIB

o. RFC 3164 BSD Syslog Protocol

p. RFC 3414 User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)

q. RFC 3418 Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)

2.07 RADIO OPTIMIZATION MANAGEMENT

A. Shall individually control band selection (2.4GHz or 5GHz), transmit power, and channel allocation.

B. Shall have option of controlling band selection either automatically or manually.

C. Shall support Auto Channel which provides an automatic means of allocating Wi-Fi channels between radios in a deployment.

D. Shall provide Auto Channel. System scans the RF environment on a radio-by-radio basis, coordinated among all AP's in the network, to determine the best channel of operation per radio.

E. Auto Channel function shall be scheduled periodically to tune the design in response to potential environmental changes.

F. Shall support Auto Cell – an automatic, self-tuning mechanism that balances cell size between AP's. Shall ensure sufficient coverage while limiting the RF energy that would extend beyond the organizational boundary between AP's.

2.08 RESOURCE MANAGEMENT

A. Shall continuously monitor wireless client behavior for potential issues.

B. If a client is detected encountering connectivity or performance issues, a notification is logged.

C. Elements to be monitored:

a. Authentication failures

b. Packet error rates

c. Packet retry rates

d. Data rates

e. Signal strength

f. Signal-to-noise ratio.

D. Shall execute local testing of radio resources and self-healing to ensure wireless service availability.

E. Automatic interference mitigation, optimized for high-density environments

F. AP shall be able to perform WIDS and spectrum analysis as well as serve clients simultaneously.

G. Wireless network controller shall actively monitor the status of key wireless network elements, including RADIUS servers, NTP servers, SNMP trap hosts, and DNS servers. If any of these elements are unreachable, a notification is logged.

H. The System shall be optionally configured to disassociate users proactively if network resources are not available so that clients do not remain connected wirelessly with no network service.

2.09 DEVICE OPTIMIZATION MANAGEMENT

A. Wi-Fi devices shall be identified by type upon connecting to the network, e.g. laptop, tablet, smartphone, gaming device, etc.

B. This information is then used to map the device to specific resources as desired. Dedicated radios and wireless networks (SSIDs) can be assigned to devices that need high bandwidth or are operating in a specific mode.

C. Shall provide Station Load Balancing

2.10 SECURE WIRELESS NETWORK

A. Shall perform packet encryption and decryption. All encryption processes are performed at line-rate in hardware.

B. Wireless encryption supported shall include the standard three encryption options:

   a. Wi-Fi Protected Access with AES

   b. Wi-Fi Protected Access (WPA2, WPA3) including WPA2 and WPA3 Enterprise

   c. WEP-40bit or WEP-128bit --only use this for legacy devices that cannot support a stronger encryption type.

   d. WPA3 and Enhanced Open support without hardware upgrade

C. Should also support TKIP and AES protocols simultaneously on the same SSID to support mixed and dynamic client environments

D. Shall include PCI and FIPS140-2 audit modes of operation to monitor for compliance.

E. Shall monitor, detect, mitigate and report on active or potential wireless threats to your network. These include:

   a. Continuous 24x7 monitoring of the wireless RF environment

   b. Detection of potential rogue or malicious APs, ad hoc, and stations

   c. Rogue device classification

   d. Automatic alerts, alarms, and logging of rogue devices

   e. Key rogue device information such as first seen, last seen, manufacturer, SSID, channel

f. Ensures compliance with wireless security policies and regulations through automated reporting

g. Continuously monitor all 802.11 channels for throughput, signal, noise, errors, and interference levels continually per channel.

i. a. Administrators centrally collect data from their desk and monitor the entire network at one time.

ii. b. Monitor all 802.11 channels, not just the ones that are currently being used for data traffic.

h. Provides device locating via analysis of Received Signal Strength Indication (RSSI) data collected by radios. This capability is available via the CLI, Web interface or Network management application, and interfaces/applications at different levels of functionality.

i. Aggregate data from multiple AP's to determine device positioning. Multi-AP design provides for even greater accuracy than single AP methods.

j. Locating in normal conditions shall provide accuracy within a 5-meter radius or better.

F. User access control protocols and features designed to classify, assign and monitor associated and unassociated clients. These include:

a. RADIUS 802.1X

b. Fully support 802.1X authentication servers.

c. MAC Access Control Lists (ACLs) supports 512 ACL entries.

d. Web Page Redirect (Captive Portal) capabilities.

e. Web based authentication against internal or external RADIUS server

f. Local host or remotely hosted captive portal or web page redirect (log-in/splash screen)

g. Failover capability by allowing the specification of primary and secondary RADIUS servers and timeout values.

h. Each SSID can specify a unique RADIUS server set enabling each SSID independent authentication control

i. Identify devices by operating systems, such as iOS®, Microsoft®, or Android™

j. Identify devices by type, such as tablet, laptop, or smartphone.

k. The device ID, along with the user ID, can be used together to map the device to a policy to control a user's reach and behavior.

2.11 LOCATION SERVICES

A. Provide Wi-Fi client location services across the entire wireless network using a Management System. Each AP provides a signal reading for each client, and the direction of the antenna provides information about the direction of the client relative to the AP.

B. Mapping-- Based on RF settings and properties of the environment, the management software shall generate heat maps showing RF coverage patterns across the environment.

C. Asset Tracking—Can have the ability to track assets across a wide variety of devices and use cases. Devices can be tracked to within 3-5 feet accuracy.

2.12 GUEST SERVICES

A. Captive Portal or Web Page Redirect (WPR), allows a guest to be presented with a web browser welcome screen before gaining access to the wireless network.

B. Directory Integration--Shall integrate with the same systems used for the wired network.

C. Policy Management--Bandwidth limits can be configured to ensure guest users do not overrun employee traffic usage. Restrictions can be placed on time-of-day access and day of the week access. Policies can be set to enforce use policies for different device types. Policies can be set and enforced on a user, role, device, and time basis.

2.13 VOICE AND MULT-IMEDIA SUPPORT (QoS)

A. Optimize application support so all standard QoS (802.11e) and Wireless Multi-Media (WMM) features including multiple traffic queues (4) and packet level identification of voice traffic. Wired to wireless QoS mapping (802.11p/q) support. Separate protocol support for the leading providers of 802.11 handsets.

B. Enable end-to-end QoS support and tag 802.1p packets

C. Shall have multicast-to-unicast conversion and IGMP snooping to optimize the performance of multicast in a Wi-Fi environment. IGMP (Internet Group Management Protocol) is used to establish and manage the membership of multicast groups. The following configuration options are available

   a. Send multicasts unmodified.

   b. Convert to unicast and send unicast packets to all stations.

   c. Convert to unicast, snoop IGMP, and only send to stations subscribed (send as multicast if no subscription).

   d. Convert to unicast, snoop IGMP, and only send to stations subscribed (don't send packet if no subscription).

   e. Each SSID can define separate traffic controls based on business requirements, including QoS (VoIP) and QoS tags can also be updated based on policy rules via the integrated firewall.

2.14 MOBILE DEVICE MANAGEMENT

A. Provide a high level of flexibility in allocating Wi-Fi users and devices among system resources to optimize overall performance.

B. Wi-Fi devices shall be identified by type upon connecting to the network (e.g. laptop, tablet, smartphone, gaming device).

C. Dedicated radios and wireless networks (SSIDs) can be assigned to devices that need high bandwidth or are operating in a specific mode. Coordinate with Owner.

D. Based on device type, specific policies can be applied such as bandwidth restrictions, application types, and time restrictions. Coordinate with Owner.

E. Resources can also be allocated based on device performance ensuring the performance of faster device types (e.g. 802.11ax) are not negatively impacted by slower devices types (e.g. 802.11b). Coordinate with Owner.

F. Users can be assigned to specific resources based on not just login information, but also client type and class. Identify the devices' operating systems such as iOS®, Microsoft® Windows®, BlackBerry®, or Android™ and can then classify the device type such as tablet, laptop, or smartphone. Once the device has been identified, a policy can be applied to control a user's reach and behavior. The device ID, along with the user ID, can be used together to map that instance to a specific user group.

G. Allow different user groups to be created with each group being mapped to specific VLANs, access control list, and QoS parameters.

2.15 APPLICATION CONTROL

A. Through software application and Deep Packet Inspection, monitor and control access to applications, prioritize critical applications, restrict usage of bandwidth-heavy applications, and block restricted applications from the network.

B. Application control shall be tied to the policy engine.

2.16 SYSTEM REQUIREMENTS

A. Wireless software management system requirements:

   a. Modular AP's Managed: 1,000

   b. Max Stations Managed: 5,000

B. Self-Healing—The system shall detect and automatically re-route traffic due to loss of communications with an access point.

C. Load Balancing—The system shall monitor AP usage in real-time and shift traffic between adjacent or over-lapping Aps to ensure the most efficient use of wireless bandwidth. The system shall also

be able to dynamically allocate signal power between Aps to compensate for changing network traffic and system configuration.

D. The contractor shall be required to fully review the existing infrastructure and conditions.

E. The Contractor shall verify that space is available in existing racks/cabinets for all new wireless equipment.

F. All wireless controller equipment shall mount in standard 19" relay racks or cabinets.

G. All patch cables required for the entire connectivity of the wireless network shall be provided and installed by the contractor.

H. The overall intent of the wireless network is to provide complete coverage of the specified area(s) as shown on the detailed drawings.

I. All electronics provided for the system shall be from the same manufacturer and shall be fully supported by the management system provided by the contractor.

J. In each communications room the equipment shall be directly connected to a ground bar that is connected to the electrical ground in the building.

2.17 SPARE AP

A. The contractor shall include with the bid, 10% but no less than ten (10) additional Aps that will be applied as needed during the site survey to correct for RF coverage issues. The contractor shall include 250’ of data cable along with termination and testing with each AP for a fully installed and operational AP. In the event that the additional Aps are not required, they shall be turned over to the Owner as “attic stock”.

PART 3 - EXECUTION

3.01 EXAMINATION

A. The Contractor shall make construction manager aware of any the site issues prior to submission of the Bid Response.

3.02 GENERAL INSTALLATION

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 system components.

C. Prior to installation of cabling for access points, the contractor shall perform an on-site validation survey. This survey shall be utilized to obtain actual site conditions including RF environment and RF properties of the construction. The validation survey shall be used by the contractor to fine tune

the AP design/lay-out and set the final quantities and locations of access points. The site validation survey shall be conducted to meet the following minimum requirements:

a. Utilize the appropriate RF sensing equipment to locate, identify and document any sources of RF activity within the area that could degrade or interfere with the WLAN.

b. Evaluate construction and possible obstacles to RF operation to determine final location of all Aps and proper selection of antenna types.

c. Evaluate potential for RF signal leakage outside the building and adjust AP locations, power settings and antennas typed to minimize leakage. The exception is specific areas of the site specifically requested to have WLAN coverage.

d. It is the Contractor's responsibility to program the devices in this section according to the Owner's Network requirements. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming.

e. Provide any miscellaneous equipment such as identification tags, cable tie, wiring harnesses, patch cables (both copper and fiber), stacking cables, etc. necessary for a complete TURNKEY system.

f. Provide all required jumper and patch cables and coordination with the Owner to connection the wired LAN.

g. Install and setup all UPS equipment. Review power down procedures with the Owner.

h. Review and modify document design to achieve minimum -65dBm coverage throughout the building and to support true 1-to-1 client support. Provide detailed report to engineer indicating any proposed changes to the quantity/locations of APs shown on the bid documents.

i. After the system is installed, the contractor shall perform a Network Validation Survey. This survey shall test the actual RF environment with the access points operating and the WLAN system functioning including all APPS designed to operate via the WLAN. The network validation will test, document and provide certification that the various operating parameters of the WLAN are being met to a degree required by the various APPS running over the WLAN. The network validation survey shall be conducted to meet the following minimum requirements.

j. Finalize channel and power settings of each AP based upon location, proximity to adjacent APs, desired data throughput, desired exterior WLAN coverage and possible sources of RF interference.

k. Review antenna selection and make adjustments to individual APs as required.

l. Verify that the system can meet or exceed the minimum recommendation of 20- 25dB SIR for VoWiFi applications.

m. It is the Contractor's responsibility to program the devices in this section according to the Owner's Network requirements. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming.

3.03 WIRELESS ELECTRONICS PLACEMENT

A. The Contractor shall be responsible for the placement of the wireless electronics and all of its components in the assigned Communications Rooms.

B. As per the Drawings, wireless AP cabling drops have been shown based on standard cabling design for AP's.

C. The actual AP placement on the drawings is for reference only and a means of showing quantities to provide.

D. Once the RF survey has been completed the contractor shall mount the AP's based on the actual field data gathered from the surveys. This may require the contractor to run patch cords from the existing AP cable drop locations to final mounting locations. All equipment shall be secured in communication racks using the maximum number of screws as there are holes provided by vendor equipment.

3.4 INSTALLATION AND CONFIGURATION

A. Contractor shall provide and install a wireless system and all associated cabling, POE devices, central controllers/switches and console.

B. It is the Contractor's responsibility to program the system in this section according to the Owner's wishes. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. The programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

C. WLAN Electronics shall provide seamless communications between Windows and Apple machines running TCP/IP protocol. Access points shall be able to accept, route and process Ethernet traffic from either platform provided they are using WiFi compliant client adapters.

D. Develop a minimum of three levels of wireless access.

a. Guest

b. Staff

c. People

d. Coordinate access privileges, VILAN, Sub-Net Assignments, Resource Allocation, etc. for each group.

e. Contractor shall configure the wireless network to support Seamless Roaming and Fast roaming among all access points

E. Enforce User Load Balancing to continually monitor user load and automatically redirect new users to alternative APs.

F. Configure Dynamic RF Management to calculate optimal 802.11 channel assignments and radio power transmission levels for all associated APs and adapts to user load, interference, RF obstacles and jamming attacks.

G. User RF Optimization shall assimilate client RF data and usage patterns along with basic RF data from access points for improved RF tuning and user performance.

H. The switch shall be configured to be VPN and Firewall Compatible. It shall be configured to provide local control of access points and not require any reconfiguration of WAN routers, VPN gateways or firewalls.

I. Configure the network to take advantage of the latest Security Standards. It shall include WPA, WPA2, WPA3, 802.11i/802.1xwith WEP, Dynamic WEP, TKIP, CCMP, EAP-TLS, TTLS and PEAP, PEAP-TLS.

J. Rogue Access Point Protection shall be configured to identify, classify and locate rogue APs.

K. Configure the system to allow patrons simple and immediate access to the internet if so directed by the owner.

L. The system shall allow administrators to get to local and wide area applications.

M. Contractor shall be onsite and shall complete a wireless site survey to coordinate placement of the data cables for the wireless access points. Complete a site survey to ensure that the AP's are placed so that they will cover the entire building for both wireless voice and data and video connectivity.

N. Provide the results of the site survey to the owner and engineer prior to installation of the Access Points.

O. Balance wireless access points to ensure complete coverage with minimal services degradation.

P. Setup Wireless Security and provide for CIPA compliance.

Q. The contractor shall be responsible for establishing the graphical floor plans of each building, along with the information required for complete RF management on a building by-building basis. The floor plans shall be updated with final AP Layouts.

R. Then contractor shall be responsible for developing and programming RF characteristics of major building components (walls, floors, windows, doors) of each floor plan to ensure more accurate RF design tool predictions.

S. The Contractor shall take information from the Owner with regards to wireless assets (laptops, PDA, wireless phone, etc.) and popular asset database to accomplish asset tracking.

T. Provide complete policy creation and enforcement as required by Owner IT staff. Coordinate with network administrators to create virtual LAN (VLAN), RF, quality of service (QoS), and security

policies. Provide multiple unique service set identifiers (SSIDs) with individual security parameters in each building. For example, a “guest” SSID can be secured with Web authentication; a “voice” SSID might be required to take advantage of the WEP, and normal data traffic can be secured using 802.11i or IPSec.)

U. Provide additional programming related to the radius server in each building to establish additional policy, authentication, and user-based privileges.

3.05 INDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent markers to demote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

C. Provide a printed, computer-generated record of each connected port in each switch. Label shall indicate AP served, port and switch label and closet label.

D. Supply a label for each AP that is installed above the ceiling with the Owner designated coding.

3.06 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the NEC article 250 and as recommended by EIA/TIA—607.

C. The Division 26 Contractor has provided 120V branch circuitry for use by the contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the system equipment. In no case shall the installation compromise the integrity of the Building Electrical Grounding System.

3.07 TESTING

A. The Contractor shall be responsible for energizing and testing Aps. The contractor shall be responsible for ensuring that the WLAN is in proper working condition.

B. The Contractor shall perform a minimum series of on-site RF survey with network verification and include the results in the O&M manuals

   a. Visual Inspection—Note condition of interior spaces along with potential barriers/obstacles to RF transmission that may not be shown on the architectural floor plans.

b. RF Spectrum Test—The Contractor shall walk the site and record the general RF environment that currently exists throughout the building. Special attention shall be paid to RF signals in the 802.11 band.

c. Ping Test—The Contractor shall walk the site recording a continuous network ping test to validate that there are no significant quantities or response time out events. Areas which result in a high number of time-out request (more than 5%) consistently long ping times (more than 5 ms) shall be flagged for further evaluation in the RF survey and AP configuration.

d. Packet Analyzer—The final AP configuration showing channel utilization, SSIDs, device MAC addresses and associated compiled signal strength measurements of a site walk.

e. Active Test—Perform active network tests in a minimum of 5 rooms throughout the building. Test shall be witnessed by the Owner/Engineer.

C. After the system is installed, the contractor shall perform a Network Validation Survey while building is fully occupied. This survey shall test the actual RF environment with the Aps operation and the WLAN system functioning including al applications designed to operate via the WLAN. The network validation with test, document and provide certification that the various operating parameters of the WLAN are being met to a degree required by the carious applications running over the WLAN. The network validation survey shall be conducted to meet the following minimum requirements:

a. Finalize channel and power settings of each AP based upon location, proximity to adjacent Aps, desired data throughput, desired exterior WLAN coverage and possible sources of RF interference.

b. Review antenna selection and make adjustments to individual Aps as required.

c. Verify that the system can meet or exceed the minimum recommendation of 20- 25dB SIR for VoWiFi applications.

D. The Contractor shall be responsible for testing and verifying that all software and management level functions of the system as required by the Owner’s Network system are programmed and operating properly. This includes but is not limited to:

a. Set-up and segregation of user groups. VLANs, security and authentication as required by Owner.

b. Set-up of multi-level security including authentication and encryption.

c. Set-up and administration of prioritization, quality of service, VoIP, etc.

3.08 TRAINING

A. Provide a minimum of sixty (60) hours of training to the Owner’s personnel and/or designated representative. Plan for multiple training trips to the site. Training session(s) shall cover the following topics at a minimum:

a. System Equipment Connectivity
b. Device Configurations
c. Operation, maintenance, and upgrade procedures.

B. Trainer must be certified by the manufacturer.

C. Training shall be coordinated with the Owner. Coordinate time, use and availability of equipment with the Owner.

D. Demonstrate adjustment, operation and maintenance of the system including each component and control.

E. Provide a copy of a sign off sheet (signed by Owner staff) for the completed training with the close-out documents.

F. Provide two (2) video copies of the training sessions.

3.09 AS-BUILT DOCUMENTATION

A. The contractor shall furnish the Owner complete as-built manuals in an indexed PDF format. They shall contain:

a. System Operating Instructions
b. System Functional Block Diagrams
c. System Schematic Diagrams
d. System Wiring Diagrams
e. As-Built Drawings of Entire System including Equipment Rack elevations
f. Component Service Manual
g. Software Operating Manuals
h. Final Endurance Test Report

B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

3.10 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

C. APs shall have a “Limited Lifetime” warranty minimum.

3.11 CERTIFICATION

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION

27.41.18 -- CONFERENCE ROOM AUDIOVISUAL SYSTEM

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, General and Special Conditions and Division 1 Sections apply to this Section.

1.02 GENERAL

A. Provide complete conference room audiovisual systems as defined in these specifications, floor plans and shown on the line drawings. All audio and video components will be professionally installed and fully integrated for ease of use. A complete system includes all audio and video components as well as connecting cables and hardware. Typical rooms included in this specification conference rooms, guidance, career, small group, teachers prep, etc.

B. The work described by this section includes the furnishing of all materials, equipment, labor and service and the performance of all operations necessary for the installation of sound systems in operating condition as indicated on the drawings and herein.

C. In general, the conduit, electrical circuits and outlets shall be furnished and installed by the Electrical Contractor. The entire responsibility of the system, its operation and function shall be that of the Systems/Electrical Contractor.

D. Provide all licenses, permits as may be applicable

E. Provision of submittal information

F. Installation in accordance with contract documents, manufacturers' recommendations, and applicable codes

G. Programming and configuration of control and signal processing software

H. Complete system testing and adjustments, including documentation thereof

I. Demonstration of complete system operation for approval

J. System operations training of owner’s staff including set up and assistance of up to three events

K. Testing and adjustments, including documentation thereof

L. Provision of custom manuals to fully detail system operation and maintenance

M. Maintenance and warranty services

1.03 APPLICABLE REFERENCES:

A. National Electric Code (NEC)

B. Underwriters Laboratories (UL)

C. Sound System Engineering (Davis & Patronis) - 3rd Edition 2006
D. Audio Systems Design and Installation (Giddings) 1990
E. Telecommunications D NFPA 70 - National Electrical Code.
F. Underwriter's Laboratory.
G. TIA/EIA-607 Telecommunications Grounding.
H. 11th Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
I. American with Disabilities Act.
J. Federal Communications Commission Part 15.
K. Sound System Engineering (Davis & Patronis) – 3rd Edition 2006.
L. Audio Systems Design and Installation (Giddings) 1990.
M. BICSI Telecommunications Distribution Methods Manual (TDMM)

1.04 QUALITY ASSURANCE

A. The intent of these Specifications is to describe and provide for a complete Audiovisual Presentation and Sound Reinforcement System of professional quality and reliability. Professional performance standards as provided by a qualified and experienced sound systems contractor (hereafter referred to as Systems Contractor) will be required. References and documentation of the System Contractor's experience and following qualifications shall be provided, if requested.
B. The Systems Contractor shall:
    a. An authorized dealer/service organization for all major items of electronic equipment furnished.
    b. Have completed, within the past two (2) years the satisfactory installation of at least three (3) systems of similar size and type as that herein specified.
    c. Maintain a factory trained service department on call 24 hours a day, 365 days a year, to service the specified product.
    d. Employ, on a full-time basis, a qualified audio/electronics Engineer under whose direction and supervision the entire installation shall be carried out. AVIXA CTS, NICET or C-EST audio certification required.
    e. Audinate Dante Level 2 Certification required
    f. Certified Crestron Programmer and DMC-E required. Or Equal certification from AMX or Extron.

C. Employ, on a full-time basis, technician(s) who are experienced in the installation of sound reinforcement equipment, its interconnection and setup. Qualified technicians shall perform the assembly, wiring, interconnection setup and programming of all equipment, jacks and devices. AVIXA CTS, NICET or C- EST audio certification required.

D. The Systems Contractor shall coordinate final utility rough-in locations with actual equipment furnished. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations, and all applicable code requirements.

E. In all cases, the Owner and Engineer shall determine the acceptability of the work based upon site visits and observations.

1.05 COOPERATION AND COORDINATION

A. Cooperate and coordinate as required with the other contractors who are responsible for work not included in this section.

B. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations, and all applicable code requirements.

C. Coordinate final utility rough-in locations with actual equipment furnished.

D. Provide any and all information as required or requested by the Owner, Engineer, or General Contractor in order for this work to be completed to the satisfaction of the Owner, and in the best interests of the Project. Such assistance or information shall be transmitted in writing to the requesting party in all cases.

E. Contractor is required to attend a minimum of 4 onsite meeting with the construction team to review and coordinate all cabling infrastructure, pathways, device rough ins, device mounting, etc. It is the contractor’s responsibility to make sure onsite rough in for the audiovisual is provided by the construction team to meet the needs of the system they are providing.

1.06 SYSTEM WARRANTY

A. Guarantee all parts, labor and workmanship furnished under this contract for the minimum period of twelve months from the date of substantial completion, or first formal use by the Owner, whichever is last to occur.

B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

C. Where manufacturers' warranties on certain equipment exceed twelve months, the guarantee period on that particular equipment shall match the extended warranty period.

D. Provide assistance to the Owner during the guarantee period of the system, as required to ensure maximum Owner satisfaction.

E. Upon completion of the work, the contractor shall submit a signed Certificate of Warranty, stating commencement and expiration dates and conditions of the warranty. Incremental warranties for completed portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor

1.07 SHOP DRAWINGS AND SUBMITTALS

A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30" x 42", 24" x 36" paper. Equipment lists, data sheets, etc. Shall be 8-1/2" x 11" size properly stored on digital media.

B. Submit to the following for approval:

   a. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item referencing the section number in Part 2 of this specification.

   b. Manufacturer's data sheets on all equipment items.

   c. System block diagram(s)

   d. Equipment rack layouts showing all rack mounted equipment items.

   e. Floor 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.

   f. Proposed construction details for all custom fabricated items, including interface panels, patch panels, and wall plates. These details shall show dimensions, materials, finishes and color selection.

   g. Riser diagrams showing conduit requirements with pull boxes, outlet boxes, part numbers of cable types used, and number of circuits in each conduit.

   h. Electrical power requirements for head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with Division 26.

   i. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

C. Control System GUI submittal: This submission shall include all proposed control system screen shots with a functional description of every button press and a flow to the actions the buttons perform. The submission shall be provided in a storyboard form. The storyboard shall include programming for all the system functions of the system. All system functions and operation steps must be clearly outlined in the storyboard. The contractor shall plan for a minimum of one onsite

meeting with the consultant and or owner to explain the proposed system operation and screen shots prior to control system approval. This submission can be provided as part of the above submittal or follow the approval of all the equipment. The objective of the control system is to be easy and intuitive to operate for anyone regardless of technical skill.

1.08 FINAL DOCUMENTATION:

A. All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner, four (4) sets of the following:

   a. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers, and quantities of each item.

   b. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and coding.

   c. Documentation of system performance measurements as noted elsewhere in this specification. Include diagrams or charts showing final setting of all control knobs in the system (mixers, equalizers, power amplifiers, etc.)

   d. Complete equipment rack layouts showing all rack mounted equipment items.

   e. Floor plans, prepared at a scale of not less than 1/8” = 1’0”, showing loud speaker locations and orientation, wall plates, rack locations and other related device locations.

   f. Riser diagrams showing installed conduit with pull boxes, outlet boxes part number of cable types used, and number of circuits in each conduit.

   g. Operations instructions for each major item of equipment furnished.

   h. Manufacturer's warranty for each major item of equipment furnished.

   i. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner’s operating personnel in the detailed step-bystep operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.09 RELATED WORK BY OTHERS

A. All conduits with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.

B. All 120 VAC power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The 120 VAC power to the equipment racks shall be terminated inside the racks to Sound Contractor - supplied isolated ground plug strips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using nonmetallic bushings or raceways.

C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground. Shall be furnished and installed under the electrical section of Division 16. Refer to the sound system drawings for additional details.

PART 2 – PRODUCTS

2.01 GENERAL

A. All equipment items shall be new, unused and the latest version or model.

B. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

C. Speaker locations are shown on the drawings for bidding purposes only. The exact speaker locations, aiming points and mounting angles shall be coordinated with the Engineer and determined through the use of an acoustical modeling program and/or good engineering practices and field conditions. Speaker aiming shall be adjusted as required after installation to provide optimal coverage and system performance.

D. Substitutions

   a. Products specified herein by manufacturer’s name and model number are intended to establish a minimal level of quality, performance and function. Proposed substitute equipment by listed equal manufacturers shall be equal in all respects to the specified product.

   b. Proposed speaker substitute requests shall additionally be supported by electroacoustic modeling data showing proposed speaker location(s)and aiming points, maximum SPL levels and evenness of coverage at key frequencies, interaction between multiple speakers and intelligibility predictions (Alcons, STI).The following sections specifically list the acceptable equipment types and items for this project. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

E. Furnish an equipment rack for use in housing the equalizers, processors, power amplifiers and ancillary devices necessary to the operation of the system.

F. Heat-producing components, such as power amplifiers, shall be mounted with one 1-3/4" vent panel installed between units. Fill all other unused portions of rack front sections with matching blank panels.

G. Furnish five (5) keys for each type of equipment rack lock installed. Lock types shall be coordinated with Owner.

H. Install the required number of units, of sufficient size to accommodate the equipment specified, at the locations indicated in the drawings.

2.02 HDBaseT TRANSMITTER WALL PLATE or (Under Table)

A. Acceptable Manufacturers Atlona AT-HDVS-210H-TX, Crestron, AMX, Extron

B. The Transmitter shall be a 2×1 switcher and HDBaseT transmitter with two HDMI inputs. It shall be one-gang, Decora-style wall plate form factor, and includes interchangeable black and white wall plates and faceplates. Video signals up to 4K/UHD @ 60 Hz with 4:2:0 chroma subsampling, plus embedded audio and control can be transmitted up to 330 feet (100 meters). The transmitter shall be HDCP 2.2 compliant. This transmitter can serve as an integral component of a fully automated AV system, with the convenience of automatic input selection and display control. It is remotely powered HDBaseT-equipped devices through Power over Ethernet (PoE).

C. Transmitter wall plates shall be located on floor plans. If shown in conference table, contractor shall mount transmitter underneath conference table and provide proper table top connectivity.

2.03 HDBaseT RECEIVER

A. Acceptable Manufacturers Atlona AT-HDVS-SC-RX, Crestron, AMX, Extron. The receiver shall be a HDBaseT receiver and 4K/UHD scaler with a local HDMI input. The receiver shall input HDBaseT for video output up to 4K/30 4:4:4, plus embedded audio, control, and Ethernet over distances up to 330 feet (100 meters). The receiver shall be capable of high-quality downscaling and upscaling, as well as a host of advanced image optimization capabilities plus video wall processing. The receiver shall be designed for use with the switching transmitters, HDBaseT switchers, HDBaset distribution amps, etc. in the system design.

B. The receiver shall have a local HDMI source input for a wireless presentation gateway.

2.04 WIRELESS MEDIA GATEWAY

A. Acceptable Manufacturers Kramer VIA GO with PAD, Barco Clickshare or equal

B. The wireless media gateway will allow wireless presentation of HD content from a variety of Smart devices including Smartphones, tablets and laptops. The gateway will be compatible with Windows, OSX, Apple iOS, and Android operating systems. The welcome screen for the gateway will be

customizable to provide clear instruction to the presenter. The gateway requires no software installation by the presenter. Gateway will operate on facility wireless network.

2.05 COMMERCIAL LED DISPLAYS

A. Manufacturers NEC E656, Sharp and LG

B. Two displays will be mounted at each location shown on drawings.

C. The display shall be a 36” diagonal screen size (unless otherwise noted), 16:9 aspect ratio with HD resolution 1920x1080 at 5000:1 contrast ratio. The display shall be designed for commercial applications in landscape or portrait. The display chassis will be an ultra-thin construction and meet ADA compliance.

D. The display will have the following inputs HDMI, VGA, Audio, Component, RS-232 control, IR, and IR ambient light sensing.

E. Display shall be wall mounted with a standard VESA style mount. The wall mount shall be securely affixed to the wall. The mount will be a tilt style wall mount designed for the specific display. Manufacturers Chief, Premier, Peerless, and Crimson AV.

2.06 LOOSE EQUIPMENT

A. 20’ M-M HDMI cable

2.07 WIRE AND CABLE

A. All wire and cables shall be new and unused.

B. Wire not installed in equipment racks, not portable, or not installed in conduit shall be fire and plenum rated and meet all applicable codes.

C. Speaker cable: West Penn 25225 stranded 16AWG twisted pair for equipment rack internal wiring and from the equipment rack pull box to the loudspeaker drivers.

D. Microphone-level and line-level audio cable (installed in conduit, not portable): West Penn 291 stranded 22 AWG twisted pair with foils shield or approved equal.

E. DANTE Audio network cables shall be CAT6. All Dante network inputs plates will 2 CAT 6 jacks on a single gang plate.

F. Digital Media cable shall be a Belden certified HDbaseT CAT cable solution for digital media applications.

G. SDI video cables shall be Belden 1694A.

H. All HDMI cables for sources and displays shall be the locking style.

I. Portable microphone cables: ProCo M-Series black flexible cable or equal by West Penn or Audio Technica.

J. Other equipment control cables shall be stranded wire, appropriately shielded, of gauge and number of conductors required by the manufacturer for proper operation of the system or equipment item furnished.

K. Wire and cable for all other devices shall be supplied in accordance with the recommendations of the device manufacturer and the National Electrical Code.

L. Acceptable cable manufacturers: Belden, Carol, General or West Penn.

2.08 JACK CONNECTORS AND WALLPLATES

A. All plate-mounted connectors shall be ground-insulated from the plates on which they are mounted.

B. All other jacks shall be installed on standard stainless steel finish plates. Nomenclature shall be engraved into the plate with 1/8” block letters filled with black paint. All mic jack locations shall be numbered consecutively, starting from one (1).

C. Unless otherwise specified, all jacks and connectors for the sound system shall be as follows:

a. Microphone and line input receptacles shall be 3-pin XLR-F with locking tab equivalent to Neutrik model NC3FP-1 or equal by Switchcraft or Studio 1.

b. Combination microphone/auxiliary input jack plates shall be impedance matching units suitable for interfacing one unbalanced high- or low-impedance source to a balanced low-impedance microphone preamplifier input. There shall be one ¼” 3-conductor phone jack marked “PROJ IN” and two RCA phono jacks marked “LINE IN L/R with a resistive mixing network to sum stereo line-level sources. A linear input level control will control the level of the auxiliary inputs. A “HUM CANCEL” rocker-type switch will selectively isolate the shields. A separate female XLR connector shall provide for a separate microphone input. There shall be no electrical connection between the impedance matching circuit and the microphone circuit. Provide Pro Co AVP-1V A/V interface jack plate assemblies or equal by Whirlwind or Conquest where shown on drawings.

c. Cable-end Microphone Connectors shall be 3-pin XLR equivalent to Neutrik model NC3XX or equal by Switchcraft or Calrad.

d. Remote Controls

i. a. Provide a remote volume control with an on/off power switch. Provide a wire cover with a key lock.

e. Furnish and install the required number of jacks and connectors as indicated on the drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All equipment shall be installed so as to provide reasonable safety to the operator.

B. All work shall be performed in accordance with the recommendations of the equipment manufacturers.

C. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable, or manufactured to UL standards. 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.

D. Installation shall follow standard broadcast wiring and installation practice and shall meet or exceed industry standards for such work, with particular attention given to any installation instructions in Parts 1 and 2 of these Specifications.

E. Equipment shall be held firmly in place with proper types of mounting hardware. All equipment affixed to the building structure must be self-supporting with a safety factor of at least six. All equipment shall be installed so as to provide reasonable safety to the operator. Supply adequate ventilation for all enclosed equipment items that produce heat.

F. All overhead or wall-mounted speaker systems shall be supported from the building structure utilizing the materials and methods required by the speaker manufacturer and providing a load-rated safety factor of 6X. All required installation material and labor shall be deemed included in these specifications.

G. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable or manufactured to UL standards.

H. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to insure that uniform polarity is maintained. Balanced audio connectors shall be wired as follows:

   a. Wire Connector Signal
   b. Black Pin #3 or Ring Lo or Neg
   c. Red or White Pin #2 or Tip Hi or Pos
   d. Bare Pin #1 or ShieldGround

I. Terminate all unused inputs and outputs with proper precision-shielded resistors. Buildout or terminate all link circuits containing active components to provide proper impedance matching. Record all pad values in the final documentation.

J. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the engineer at the time of final equalization and testing. Shields of audio cables shall be grounding at one the sending end only of the various active interconnected equipment items in the system.

K. Route cables and wiring within equipment racks and cabinetry according to function, separating wires of different signal levels (video, microphone level, line level, amplifier output, 120VAC, intercom, control, etc.) by as much physical distance as possible. Neatly arrange and bundle all cables loosely with plastic cable ties. Cables and wires shall be continuous lengths without splices.

L. All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heatshrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.

M. All cables in conduits shall be insulated from each other and from the conduit the entire length and shall not be spliced. All cables and wires are to be continuous lengths without splices.

N. All solder joints and terminations shall be made with rosin-core silver solder.

O. Temperature regulated soldering irons rated at least 60 watts shall be used for all soldering work. No soldering guns or temperature unregulated irons shall be used.

P. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts will not be accepted except in the case of distributed, constant-voltage speaker systems.

Q. Each mechanical connector shall be attached using the proper size controlled-duty-cycle ratcheting crimp tool that has been approved by the manufacturer of the connectors. Conventional non-ratcheting type crimping tools are unacceptable and shall not be used on the job site.

R. Label all wires in racks and at consoles as to destination and purpose. Clearly and permanently label all jacks, controls, and connections with permanent engraved laminated plastic labels or by engraving and filling mounting plates, unless otherwise noted. Attach laminated plastic labels with contact cement. Embossed or printed label tape, and press-on or lift-off lettering systems will not be accepted. All labeling shall be completed prior to final system inspections. If permanent labels cannot be furnished prior to final system inspections, temporarily label all controls with write-on tape.

3.02 LABELING

A. Clearly and permanently label all jacks, controls, and connections with engraved laminated plastic labels or with engraved and back-filled mounting plates. Attach laminated plastic labels with contact cement.

B. Identify and permanently label all wires and cables at every point of termination and connection point with industry-standard cable markers. All cable identifications shall be logged, marked on drawings where appropriate and included in the owners' manual.

3.03 CABINETS, CABLES, CONNECTORS AND MISCELLANEOUS EQUIPMENT

A. Equipment Cabinets

a. Locate freestanding equipment cabinet(s) where indicated and provide service access to both front and rear without having to move cabinets.

b. The 120 VAC power to the equipment racks shall be terminated inside the racks to plug mold plug strips or quad convenience outlets.

c. All conduit systems shall be insulated from the equipment racks using nonmetallic bushings or raceways.

d. Install equipment in cabinets using solid and vented panels and fans as required to provide adequate ventilation in accordance with industry standard principles of thermal management and recommendations of specific equipment manufacturers. Fill all unoccupied rack space with blank or ventilating panels finished to match cabinet color.

e. Connect all microphone, line level, DC control and speaker cables to equipment cabinets via approved audio terminal blocks. Use spade lugs if barrier strips are used. Do not buss commons together. Do not ground.

f. Locate patch panels and all frequently used controls at least 30" above floor.

g. Signal processing equipment with front panel controls that are to be permanently set (e.g. equalizers, limiters, digital delays) shall be furnished with security panels or sub-panel mounted behind blank panels. Provide plastic vision panels to allow viewing of operational indicators such as meters or clipping indicators.

B. Wiring and Interconnections

a. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to ensure that uniform polarity is maintained. Balanced audio connectors shall be wired with shield at Pin #1, hi/positive at Pin #2.

b. Build-out all link circuits containing active components where necessary to provide proper impedance matching and optimum gain structure for maximum operating headroom and signal-to-noise ratio. Record all pad values in the final documentation.

c. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the Engineer at the time of final equalization and testing. Shields of audio cables

installed between active interconnected equipment components shall be grounded at the sending end only.

d. All cables shall be installed in conduit except above accessible ceilings, where they shall be supported utilizing J-hooks or bridle rings on minimum 4 ft. centers. Provide an electrical wall box with conduit stubbed above accessible ceilings for all wall-mounted peripheral devices.

e. Separate conduits and/or cable harnesses shall be maintained for cables in the following categories:

   i. Levels below -20 dBm (microphone).

   ii. Nominal levels from -20 dBm to +30 dBm (line).

   iii. Loudspeaker

   iv. Control

   v. Power

f. Group and route all cables within equipment cabinets according to type and function and separate according to signal levels. All cables shall be continuous lengths without splices.

g. All system wire shall be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat shrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.

h. All solder joints and terminations shall be made with rosin-core silver solder.

i. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts are not acceptable except in the case of distributed, constant-voltage speaker systems.

3.04 GROUNDING

A. Ground active components, equipment cabinets and audio line shields to independent audio system ground and to the ground buss in the power panel.

B. Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from sound system, including audio equipment cabinets and audio system ground.

C. Insulate all conductors, including shields, from conduit, backboxes and from each other for the entire conduit length.

D. Take such precautions as may be necessary to prevent and guard against electromagnetic and electro-static hum and to install the equipment so as to provide normal and reasonable safety for the operator.

3.05 TESTING

A. The completed sound system is to be inspected and tested for compliance with the Specifications.

B. The testing and equalization work shall be performed after the installation work has been completed, but prior to any use of the system.

C. The process of equalizing and testing the system may necessitate moving, adjusting or re-aiming certain loudspeakers. Adjustments shall be performed without claim for additional payment.

D. Coordinate as necessary to ensure a totally quiet room during the sound reinforcement systems testing and balancing period.

E. Prior to requesting systems acceptance testing, verify the following:

   a. All systems are in first class working condition and free of short circuits, ground loops, parasitic oscillations, excessive system noise beyond published specifications of the equipment, hum, RF interference, or instability of any form.

   b. All loudspeaker circuits have been tested, properly and are in perfect working order. Furnish impedance measurements of each circuit prior to final tests.

   c. All equipment controls are labeled, even if unused

   d. Operation manuals for every furnished equipment item are on hand at the job site.

F. Should the performance testing show that the Contractor has not properly completed the systems, the Contractor shall make all necessary corrections or adjustments, and a second demonstration shall be arranged at the Contractor's additional expense.

3.06 SYSTEM PERFORMANCE

A. After equalization and testing, the sound system shall meet or exceed the following specifications:

   a. System shall be free of short circuits, ground loops, parasitic oscillation, excessive system noise, hum, RF interference and instability of any form.

   b. Maximum SPL with band limited pink noise input to the system shall be 100dB before audible distortion or clipping occurs.

   c. Seat to seat variation of SPL at 4kHz octave band pink noise shall be within a tolerance of plus or minus 3dB.

   d. Acoustic response of the system shall be plus or minus 3dB along a line which is flat from 100Hz to 3000Hz and which rolls off at 2dB per octave to 20kHz.

3.07 TRAINING

A. The Contractor shall furnish the Owner's representatives with training necessary to properly operate the systems. Demonstrate in detail all functions of the systems. Provide a minimum of one (1) hour of instruction and familiarization for this purpose.

B. The training phase shall be accompanied by complete as-built documentation and the custom Technical System Operation manual.

3.08 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

SECTION 27.41.19 - AUDIOVISUAL EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SCOPE OF WORK

A. The work described in this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of audiovisual equipment in operating condition as indicated on the drawings and/or specifications.

B. In general, the conduit and/or cable tray, junction boxes, electrical power circuits and outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed by the Electrical Contractor under a separate contract. The entire responsibility for the system, its installation, operation and function shall be that of the Systems Contractor.

1.03 SECTION INCLUDES

A. Work consists of new A/V equipment including:

   a. Video display complete with wall/ceiling mounting hardware and connection to the local audio/video system as detailed on the drawings and as specified herein.

   b. Data projectors complete with wall/ceiling mounting hardware and connection to the local audio/video system as detailed on the drawings and as specified herein.

B. A/V Distribution Systems are required to be complete with sources, inputs, displays, distribution, controls and connection to the data network and video distribution system as detailed on the drawings and specified herein.

C. All material and/or equipment necessary for proper operation of the system(s), not specified or described herein, shall be deemed part of these specifications.

1.04 QUALITY ASSURANCE

A. All equipment shall be UL listed.

B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.

C. All equipment Installation Practices shall comply with the Local Electric Code.

D. All equipment and installation practices shall comply with the latest AVIXA Installation Handbook.

E. All equipment and Installation Practices shall comply with the latest BICSI ® Telecommunications Distribution Methods Manual (TDMM).

F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards as applicable.

G. Performance Verification: All digital video systems shall be pre-tested to verify the complete compatibility of all sending, receiving and distribution components and the performance and integrity of the transmission media. The performance of each system shall be demonstrated, with all proposed components, in the presence of the Design Engineer and/or Owner prior to approval and installation. Any system failing to meet the specified performance requirements shall be rejected and re-configured as required prior to re-testing.

H. A mock-up and meeting shall occur for typical presentation wall technology where interactive projectors and/or interactive flat panels occur. Wall shall be finished and projector markerboard and/or visual wall display wallcovering, interactive projector and/or interactive flat panel, data and AV connectivity, electrical and all accessories shall be installed. Construction manager, architect, projector markerboard and/or visual display wallcovering installer/contractor, technology installer/contractor, and electrical installer/contractor shall be present to review mock-up. Purpose of mock-up is to confirm interactive technology is functioning as intended, that there is proper coordination between the wall surface, the projector markerboard, or visual display wallcovering and the interactive projector and/or interactive flat panel. All final mounting heights for different rooms and spaces shall be confirmed at the mock-up review.

I. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.

J. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.05 CONTRACTOR QUALIFICATIONS

A. The A/V equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the A/V contractor to utilize a Subcontractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. Equipment supplier shall have a service organization within 75 miles of the project site.

D. The Contractor shall have on staff an AVIXA certified CTS-I AV systems engineer/project manager responsible for overseeing the project and the lead technician (not installers) shall have a CTS certification.

1.06 SHOP DRAWINGS AND SUBMITTALS

A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30” x 42”, 24”x 36” paper. Equipment lists, data sheets, etc. Shall be 8-1/2” x 11” size properly bound into a single or multiple volumes.

B. Submit to the following for approval:

   a. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.

   b. Manufacturer's data sheets on all equipment items.

   c. System block diagram(s)

   d. Equipment rack layouts showing all rack mounted equipment items.

   e. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

1.07 FINAL DOCUMENTATION

A. All final documentation shall be submitted And approved before final acceptance by the owner will be granted. Within 45 days after completion of the work, deliver to The owner, four (4) sets of the following:

B. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.

C. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and coding.

D. Complete equipment rack layouts showing all rack mounted equipment items.

E. Operations instructions for each major item of equipment furnished.

F. Manufacturer's warranty for each major item of equipment furnished.

G. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner’s operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.08 COORDINATION

A. Coordinate Work of this Section with the owner, owner's integrator, owner's ITC-site, CM and Architect.

B. Meet jointly with representatives of above organizations and Owner's representatives to exchange information and agree on details of equipment arrangements and installation interfaces.

C. Record agreements reached in meetings and distribute record to other participants.

D. Confirm a schedule time frame that all equipment will be installed, all documentation will be delivered that is needed for the implementation, and service provider requirements and installation time frame.

E. Coordinate with all other trades and provide connection interfaces as applicable.

F. Coordinate all power and load requirements with UPS requirements so that all UPS equipment is properly sized for submittals.

1.09 STORAGE OF MATERIALS

A. All materials shall be secured when not in use by the Contractor.

B. It shall be the Contractor's responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.10 RELATED WORK BY OTHERS

A. All conduit with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.

B. All power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The power to the equipment racks shall be terminated inside the racks to Contractor - supplied isolated ground plugstrips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.

C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground.

1.11 WARRANTY

A. The equipment shall be warranted by both the contractor and manufacturer for a period of three (3) years from date of substantial completion.

B. Provide proof of warranty from manufacturer.

C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

D. The vendor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner. If equipment cannot be repaired within 24 hours of service visit. Contractor shall provide “loaner” equipment to the Owner at no charge.

PART 2 - PRODUCTS

2.01 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications

2.02 LED TV MOUNTS

A. Provide wall type, articulating arm LCD mounts with 20 degrees of forward tilt and 180 degrees of side to side swivel. Mounts shall be rated for commercial use and capable of supporting up to 60” flat panel Televisions.

B. Component Storage Panel, Sliding

C. Chief Component Storage Panel, Sliding CSSMP15X10 attach directly to the display mount and offer convenient, local small device mounting. This option for locating technology behind the display features complete location flexibility. The included mounting arm attaches directly to any side of your chosen VESA mount, and features multiple locations for attachment of the mounting plate to the arm. Featuring our patented UMS pattern for mounting of small devices and components, this mounting plate offers 9" x 12" of mounting space.

D. Mounts shall be installed in strict compliance with the manufacturer’s instructions. Mounting configuration, method, and exact location of mounts to be approved prior to installation.

2.03 INTERACTIVE FLAT PANEL PORTABLE MOUNT

A. Display Size: 36”-100”

   a. Mobile cart with height and tilt adjustment

   b. 15” of height adjustment

   c. Mobile base, H-shape, RAL 9006 white aluminum

   d. Mount for use with 36” – 100” display

e. VESA 200 x 200 up to 800 x 600

f. Maximum load approximately 150 kg

2.04 CEILING PROJECTOR MOUNTS

A. Supports projectors up to 50 lbs.

B. Adjusts from 7”-27”

C. Includes wall-mounted storage box

D. Integrated cable management

E. Mounts to single and dual studs, steel studs and concrete

F. Includes universal projector mounts (Model: PDS-PLUSW)

a. +/-16.5° tilt

b. +/-7.5° roll

c. 360° yaw

G. Lifetime Warranty

H. Model: Premier, Peerless, or Chief

a. Mounts shall be installed in strict compliance with the manufacturer’s instructions. Mounting configuration, method, and exact location of mounts to be approved prior to installation.

I. Shall adhere to the Safe Working Load and Working Load Limit as specified by the manufacturer.

J. Shall use Grade 5 bolts to mount.

2.04 ULTRA-SHORT THROW PROJECTOR WALL MOUNT

A. Shall be compatible with Ultra-Short Throw Projector manufacturer.

B. Support up to 50 lbs.

C. Shall extend 7-15” from wall.

a. +/-16.5° tilt

b. +/-7.5° roll

c. 20° yaw

D. Shall adhere to the Safe Working Load and Working Load Limit as specified by the manufacturer.

E. Shall use Grade 5 bolts to mount.

2.05 INTERACTIVE ULTRA-SHORT THROW PROJECTORS

A. General Note: Connect all projectors to associated sound systems in rooms and large venue areas where sound systems are provided.

B. Provide Projectors with Ethernet connection and central management software.

C. Refer to drawings for locations.

D. Projection System: 3LCD, 3-chip technology

E. Projection Method: Ceiling / wall mount / table mount

F. Driving Method: Poly-silicon TFT Active Matrix

G. Pixel Number: 2,304,000 dots (1920 x 1200) x 3

H. Color Brightness - Color Light Output: 4000 lumens

I. White Brightness - White Light Output: 4000 lumens

J. Aspect Ratio: 16:10

K. Native Resolution: 1920 x 1200 (WUXGA)

L. Throw Ratio Range: 0.22 – 0.37 (16:10), 0.33 – 0.44 (4:3), 0.27 – 0.37 (16:9)

M. Size - projected distance: 70.4" – 100" (16:10)

N. Keystone Correction: Horizontal: ±3 degrees, Vertical: ±3 degrees

O. USB Plug 'n Play: Mac OS X® 10.7/10.8/10.9/10.10/10.11/macOS® 10.12.x Windows Vista®/Windows 7/ Windows 8/Windows 10

P. Contrast Ratio: Up to 2,500,000:1

Q. Color Reproduction: Up to 1 billion colors

R. Light Source Life: 20,000 hours (Normal), 30,000 hours (Extended)

S. Interactive Specifications

    a. Computer Interactivity Control—Include necessary software and drivers for USB

T. control including USB extenders and RJ45 adaptors as specifically

U. recommended by the manufacturer for complete operation.

    a. Interactive Technology: Infrared; 940 nm

    b. Interactive Area: 70" to 100" diagonal (16:10, WUXGA)

    c. Interactive Modes:

        i. Computer interactivity / input

        ii. Interactive and Whiteboard modes, Dual user

        iii. PC-Free input

        iv. Annotation, Single user

        v. Calibration Method: Automatic or Manual

        vi. Interactive Connectivity: USB cable required

        vii. PC-Free Annotation: Supported, single user

viii. PC-Free Annotation Tools

ix. PC-Free Annotation Sources: Document cameras, DVD / Blu-Ray player, iPod® / iPad devices5

V. Wireless

W. Projector shall be wall-mounted with security hardware. Include all mounting hardware necessary. Coordinate mounting height and location of projector to provide full video image on screen. Provide all required power, control, audio and video patch and extension cables required to operate the projector.

X. Shall adhere to the Safe Working Load and Working Load Limit as specified by the manufacturer.

Y. Shall use Grade 5 bolts to mount.

2.06 WIRELESS PRESENTATION SYSTEM

A. Features

a. AC adapter or Power over Ethernet

b. Connectivity

i. Windows (1) Miracast

ii. macOS (1) Airplay

iii. Chromebook (1) Google Cast

iv. Linux

v. iOS

vi. Android

c. Resolution 1080p up to 60 fps

d. Presenter mode

i. Single window sharing

ii. Extended screen with AirPlay + Miracast, single app sharing

e. One-to-many screen sharing

i. desktop app

f. Security

i. Works on enterprise networks

ii. Pin code connect

iii. Web Proxy support

g. Device management

i. Bulk updates

ii. Remote updates

iii. Different access levels

h. Digital signage

i. Websites

ii. Videos

iii. Custom images

i. Productivity apps and dashboards

j. Calendar sync for room management

2.07 DIGITAL DISPLAY MONITORS

A. Basis of Design Samsung 4K Smart TV, LG or equal

B. Panel

a. Size—Refer to drawings

b. 4K UHD TV with Full Array Backlighting Resolution 3840 x 2160 Minimum

c. Motion Rate 120 MHz

C. Broadcasting System

a. ATSC, Clear QAM/VSB

D. Audio

a. Audio Output 40W

E. Interface

a. USB 2.0 (3)

b. HDMI (4)

c. Ethernet (1)

d. RF In (1)

e. Digital Audio Out

f. PC Audio Input

g. Audio Out (Mini Jack)

h. RS-232C

F. Features

a. Smart TV with App

b. Full Web Browser

c. OSD Language—English, Spanish, French

d. HDMI-CEC
e. Channel Guide
f. VChip
g. Bluetooth
h. Mirroring
i. DLNA

2.08 INTERACTIVE FLAT PANEL 75”

A. Manufacturers Basis of Design: Clevertouch Plus 75” or equals by Clear Touch or NEC The Interactive Panel shall be a USB HID standard interactive flat panel LED display with ten touch points, one digital pen, two stylus, a licensed copy of interactive software and manufacturer’s warranty. Full HD or 4K UHD displays.
B. Interactivity - 20 points for gestures and multi-user collaboration, including digital pen for differentiated input
C. Touch Points: 20
D. Screen Type: LED
E. Aspect Ratio: 16:9
F. Resolution: 4K Ultra HD
G. Brightness (cd/m2): 350
H. Android
I. Glass: Anti-Glare
J. Response Time (Touch): <15ms
K. Contrast Ratio: 1200:1
L. Connectivity
    a. CVBS
    b. USB 2.0 / 3.0 / Touch
    c. DisplayPort in 1
    d. HDMI 1.4 In / 2.0 In
    e. HDMI Out
    f. PC-Audio
    g. R/L (CVBS) With video IP
    h. LAN (RJ45)
    i. RS232

j. Module Slots: 2

M. Power: <450W

N. VESA Mount

O. Android Capabilities

P. OTA Update

Q. System Version Android 6.0 Mashmallow

a. CPU: Rockchip 3399 Dual-core, ARM Cortex A72 & Quad-core, ARM Cortex- A53

b. Android Resolution 2160p/UHD (LUX UI is 2K)

c. GPU Mail-T860, OpenGL ES1.1 /2.0 / 3.0 / 3.1

d. RAM 4GB

e. ROM 16GB

R. 801.11ac Wi-Fi Enabled

S. Apps and Android Features

a. Email Out

b. Note App

c. Lynx App

d. Cleverstore

e. Clevershare App

f. Eshare

T. Accessories

a. USB Camera Ability

b. Writing Stylus

c. VGA, Audio Cables

d. HDMI, USB Cables

e. Clevershare

f. Clevercable

U. Provide security lock to mount

V. Shall adhere to the Safe Working Load and Working Load Limit as specified by the manufacturer.

W. Shall use Grade 5 bolts to mount.

2.09 DOCUMENT CAMERA

A. Basis of Design: IPEVO Ziggi HD Plus
B. High-definition resolutions up to 3264 x 2448
C. Full autofocus lens
D. 12x continuous digital zoom
E. Up to 30 fps live video capture (at full HD)
F. USB 2.0 Video Class (UVC) interface
G. Mac, Windows PC & Chromebook compatible
H. Max shooting area: 13.46” x 10.04” (342 x 255mm)
I. LxWxH (when folded): 10" x 3.1" x 1.5" (255 x 80 x 40mm)
J. Weight:1.62lbs (737g)
K. USB cable length: 4.9ft (150cm)
L. Color: Gray
M. Model name: CDVU-06IP
N. Compatible with: PC, MAC, Chromebook

2.10 VIDEO CONFERENCING ALL-IN-ONE SYSTEM

A. General
    a. Bluetooth® wireless technology
    b. RF remote control
    c. TV mount
    d. Kensington security slot
B. System Requirements
    a. Windows® 7, Windows 8.1, or Windows 10
    b. macOS® 10.10 or higher
    c. Chrome OS™ Version 29.0.1547.70 and higher
    d. USB 2.0 port (USB 3.0 port and cable required for 4K video)
C. Light
    a. Low-light compensation
    b. Video noise reduction
    c. Low-light saturation optimization
D. Sight
    a. Human figure detection

b. Auto-frame participants at meeting start
c. Auto-frame participants on-demand
d. Auto-reframe when participants enter, leave, or change positions

E. Sound
a. Machine learning AI trained to distinguish human speech from other sounds
b. AEC (Acoustic Echo Cancellation)
c. VAD (Voice Activity Detector)
d. Background noise suppression
e. Auto-level loud and soft voices
f. Peak-limiting algorithm eliminates even momentary speaker clipping to prevent distortion
g. Anti-vibration enclosure

F. Compatibility and Integrations
a. Plug-and-play USB connectivity
b. Certified for Skype™ for Business and ready for Teams
c. Zoom™ Certified
d. Fuze™ Certified
e. Certified for Google Hangouts Meet Hardware
f. Microsoft Cortana®
g. Cisco Jabber®
h. Compatible with BlueJeans, BroadSoft™, GoToMeeting™, Vidyo™, and other video conferencing, recording, and broadcasting applications that support USB cameras

G. Camera
a. Lens with 5x HD zoom and motorized pan (+/- 25°) and tilt (+/- 15°)
b. Field of view: Diagonal: 120°, Horizontal: 113°, Vertical: 80.7°
c. Total Room Coverage (field of view + pan and tilt): 163° wide x 110° tall
d. 3 camera position presets
e. Auto-framing (requires Windows 10 64-bit or macOS)

H. Video performance:
a. 4K Ultra HD video calling (up to 3840 x 2160 pixels @ 30 fps with customer supplied USB 3.0 cable)
b. 1080p Full HD video calling (up to 1920 x 1080 pixels @ 30 fps)

c. 720p HD video calling (up to 1280 x 720 pixels @ 30 fps)

I. Microphone

a. Integrated microphone with 3 beamforming elements

b. Pickup Range:

i. 4 meters (13.1 feet)

ii. With Expansion Mic: 5 meters (16.4 feet)

c. Sensitivity: -27dB

d. Microphone frequency response: 90Hz - 16kHz for full voice reproduction and high intelligibility without noise

e. Beamforming performance: Factory-paired, very low distortion broadside beamforming algorithm steers the microphones directly at the talker for the best voice pickup and noise reduction

f. AEC (Acoustic echo cancellation)

g. VAD (Voice activity detector)

h. Microphone background noise suppression

i. Microphone date rate: 32 kHz sampling rate

j. Recommended # of participants: 6

k. Recommended # of participants with expansion mic: 8

J. Speaker

a. Volume adjustable to 95 dB SPL at 1/2 meter peak

b. Speaker sensitivity 86.5+/-3dB SPL at 1/2 meter

c. Distortion: 200 Hz - 300Hz < 3%, 3000 Hz -10KHz < 1%

d. Anti-vibration enclosure improves voice clarity while limiting sound transmission to adjacent spaces

2.11 AUDIO/VISUAL PATCH CABLE

A. Provide all associated A/V patch cables for each equipment item for a fully operational system. All patch cable shall be equipped with ferrite bead devices.

a. M/M 1/8th” audio cables 3FT

b. HDMI Cables 3FT

c. USB Cables 3FT

2.12 SURGE SUPPRESSION

A. For all display devices: The surge suppressor shall be a compact mountable unit in a magnetic shielding steel enclosure. It shall operate from 120 volts AC and include a separate 3 foot, grounded 3-wire #18 line cord. There shall be 2 grounded AC receptacles. It shall have a load rating of 9 amps @120 volts. It shall be UL listed and certified to Federal Grade A, Class 1, Mode 1 guidelines for powerline surge suppressors. The unit shall provide auto-resetting overvoltage shutdown. There shall be three limiter circuits: a pulse inverter, series surge reactor current limiter, and a cascaded auto-tracking dual-polarity voltage limiter. The onset clamping voltage shall be 172 volts nominal, and the unit shall have an instant-reacting snubber to protect against fast-rising surges generated within the installation location. The surge suppressor shall have an unlimited Applied Surge Current rating (8 x 20 us0 and shall withstand at least 1000 occurrences of Surge Pulse Voltages up to 6000 volts.

2.13 CONNECTORS AND PLATES

A. Jackplates

a. Outlet faceplates shall be custom fabricated, aluminum plates or all- metal modular frames with metal, screw/nut jack modules. Voice/data- style plastic plates/modules with “snap-in” jack modules are not acceptable.

b. Each and every audio/video and CATV jack shall be labeled to indicate function (audio “L” and “R”, video, catv, etc.). Coordinate labeling scheme with Owner. Labels shall be engraved and backfilled or adhesive laminated plastic. P-touch labels or labels applied with pens or markers are not acceptable.

c. Data jacks, where shown integrated into custom jack plates, shall be provided by the structured cabling provider and shall adhere to the provided channel solution. Custom cut-outs shall be coordinated with the structured cabling contractor to provide an exact fit for the RJ-45 module as provided, labeled, and terminated by the structured cabling installer. Each data jack shall be labeled to corresponding patch panel and port.

d. Jacks to be installed in floor boxes/poke-thrust to be installed in faceplates, compatible with floor box / poke-thru make / model and secured within floor box / poke-thru. The use of loose or un-mounted jacks shall not be acceptable.

e. Refer to drawings for arrangement of various workstation jack plates including jack types and quantities within each jack plate type. All jacks associated with audio/video system indicated in each faceplate shall be deemed included in this specification unless specifically noted otherwise.

B. Manufacturers: Ace Backstage, Panel Crafters, ProCo, Covid, RCI Custom or Hubbell.

C. Provide any/all pre-made A/V patch cables as required for a fully operational system. All jack plates must be provided with a patch cable for all used/unused A/V jacks.

D. Patch cable lengths may need to be adjusted in some situations to facilitate a neat and professional installation.

E. The A/V Contractor shall be responsible for final dressing of all patch cables at each item of equipment to provide a neat and orderly appearance.

2.14 PATCH CABLE MANAGEMENT – END DEVICES

A. Provides continuous abrasion protection for wires, cables, hoses, and tubing. Highly flexible open weave will not trap heat or humidity, allows for irregular shapes. Lightweight and durable protection. Panduit Part# SE50PSC-CR0

B. Miscellaneous – Provide all additional required equipment, connections, terminations, and cabling between items of equipment for a complete and operational system.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount all equipment using manufacturer's recommended hardware.

B. Connect Devices to IP Network for Central Control.

C. Adjust all Projectors for proper focus, keystone correction and display size.

   a. Projectors should project to both Interactive White Board and screen without needing adjustments made.

D. Install all associated software monitoring and control programs.

E. Equipment shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all local, city, state and national codes.

F. Provide all hardware, framing members, etc. as required for mounting equipment.

G. Coordinate all structural mounting points and locations and load requirements with Architect/General Contractor.

H. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.

I. The installation of all work shall be neat and of professional quality. Cooperate with other trades to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

J. Installation shall follow industry standard wiring and installation practice and shall meet or exceed industry standards for such work, with attention given to any installation instructions in Parts 1 and 2 of these Specifications.

K. Equipment shall be secured firmly with proper types of mounting hardware. All equipment affixed to the building structure must be self-supporting with a safety factor of at least three unless otherwise stated.

L. All equipment shall be installed to provide reasonable safety to the operator.

M. All overhead or wall-mounted speaker systems shall be supported from the building structure utilizing the materials and methods recommended by the speaker manufacturer and good rigging practices, providing a load-rated safety factor of six (6). All required installation material and labor shall be deemed included in these specifications.

N. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable or manufactured to UL standards.

O. It will be the responsibility of this contractor to provide all programming.

P. In addition to the GUI provided the technology systems contractor will provide an Ethernet based executable GUI for interfacing to the system.

Q. Technical Systems Manual, custom-written by the Contractor, for instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventative maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

R. Equipment shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all local, city, state and national codes.

S. Provide all installation hardware as required for mounting video displays, projectors and speakers. Coordinate all structural mounting point locations and load requirements with architect and general contractor.

T. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.

U. The installation of all work shall be neat and of professional quality.

V. Cooperate with other trades to achieve well-coordinated progress and satisfactory final results.

W. Execute without claim for extra payment for minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

3.02 FLAT PANEL INSTALLATION

A. Contractor shall field verify the location of each flat panel with surrounding structural elements and room furnishings at the proposed mounting location to ensure proper installation prior to mounting equipment. Where field conditions will not provide the correct application for the proposed flat panel type/location/mounting method, the contractor shall notify the Engineer/Architect in writing. Notification shall include proposed alternatives for review.

B. Flat panel displays shall be mounted straight, level and true.

C. Contractor shall custom configure the flat panel video/image/setting menus once source equipment and AV system is operational. Flat Panels with tuners shall have the broadband CATV channels scanned and programmed once the system is active. Flat panel set-up shall be completed, and the optimal settings stored for later recall.

D. Programming of flat panels and centralized AV control software including all network assignments, passwords, schedules, etc.

3.03 WIRING INSTALLATION

A. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to ensure that uniform polarity is maintained. Balanced audio connectors shall be wired with shield at Pin #1, hi/positive at Pin #2.

B. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the Architect/Engineer at the time of final equalization and testing. Shields of audio cables installed between active interconnected equipment components shall be grounded at the sending end only.

C. All cables shall be installed in conduit except above accessible ceilings, where they shall be installed utilizing J-hooks or bridle rings on minimum 5 ft. centers or cable tray, where available.

D. Separate conduits and/or cable harnesses shall be maintained for cables in the following categories

   a. Levels below -20 dBm (microphone).

   b. Nominal line levels from -20 dBm to +30 dBm (line).

      i. Loudspeaker

      ii. Control

      iii. Power

      iv. Video

E. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

F. Group and route all cables within equipment cabinets according to type and function and separate according to signal levels. All cables shall be continuous lengths without splices.

G. Cables shall be handled and installed with extreme care. Tie wraps shall loosely hold cables; do not over-tighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 4 times the outer diameter of the cable. The cable manufacturer's recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

H. Cable pathways shall provide the following minimum clearances (parallel or perpendicular)

   a. Motors and transformers – 48".
   b. Conduit and cable used for electrical power distribution – 12".
   c. Fluorescent lighting – 5".
   d. Power lines up to 2kVA – 5". e) Power lines over 5kVA – 24".
   e. Hot water/steam lines - Bare –18", Insulated – 6".

I. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

J. All system wire shall be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat shrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.

K. All solder joints and terminations shall be made with rosin-core silver solder. No lead-based solder shall be accepted.

L. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts are not acceptable except in the case of distributed, constant-voltage speaker systems.

3.04 PROGRAMMING

A. AV Distribution System and touch panel controller shall be programmed as described herein and as required by owner. Contractor to develop system programming through a series of meetings, storyboard submittals and a final virtual run-through prior to programming. Programming shall be submitted to Owner prior to application for approval.

B. Program flow drawings shall be submitted by the contractor for review prior to any programming taking place. No fewer than three meetings shall take place regarding program flow and touch panel interface prior to any programming being started Program flow review with follow-up email communication and approval or in-person meetings as necessary.

C. Technical review of touch panel (mock-up touch panel will be required at this meeting).

D. End-user touch panel review of mock-up touch panel
    a. Present must be the AV Vendor Engineer and an Owner's representative.
    b. End users will also be present at the end-user review of mock-up touch panel.
E. If necessary, access to the Owner's network for programming can be granted. Any request for this type of access should be submitted in writing no fewer than ten (10) business days prior to need.
F. JPEG screen shots will be required of the touch panel once the design is final so that the end-user may begin to create a user instruction guide.
G. Touch panel controller shall be programmed as described herein. Programming shall be submitted to the Owner as outlined in Supplemental Instructions below.
H. Programming - Touch panel controller shall be programmable with graphic page as required to offer controls for A/V equipment connected to the system. Unit shall be programmed per the owner's requirements to provide the following controls at a minimum:
    a. There shall be a welcome page with simple system on/off features and custom Owner logo and a home page with the most often used control features. For bidding purposes, plan for a minimum of 10 user pages with 5 additional technician level pages.
    b. Controls for system on/off, system volume and mute, and user "blackout" shall be accessible as fixed hard buttons.
    c. There shall be provided full component control of all sources.
    d. DSP control shall allow for system-wide mute and volume control.
    e. There shall be Technician level control pages, password protected that allow complete access to all component features including system menus.

3.05 TESTING

A. Verify picture quality on all A/V inputs.
B. Test all associated software control programs.
C. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Architect to demonstrate satisfactory performance.
D. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.
E. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; Submit report indicating result to the Engineer.

F. A qualified technical representative of the system contractor shall do systems acceptance testing. Installation must be complete in all respects before acceptance testing. Acceptance testing and training must be scheduled on separate dates to allow time for corrections, if necessary. Once all functions and devices within the system have been adequately demonstrated to be working properly, a complete owner's manual will be presented to the Owner's agent. It shall contain a comprehensive list of all supplied equipment, a complete point-to-point system wiring diagram with "AS BUILT" wire numbers indicated, details of hook-up connections including build-out devices (active and passive), systems control settings record, the final test results including plotted frequency response curves, operation and maintenance manuals for each active device including schematic diagrams and parts list. A thoroughly completed commissioning checklist (re: InfoComm's AV Installation Handbook Appendix J: Audiovisual Systems Commissioning Tests Checklist) shall be included with the Owner's Manual.

G. The Contractor shall be prepared to verify the performance of any portion of the system by demonstration, listening tests and/or instrument measurements.

H. Measurement of frequency response, distortion, noise, or other characteristics shall be performed (or a demonstration test requested) if deemed necessary to determine proper operation.

I. The Contractor shall make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Engineer as a result of acceptance tests.

J. Test Reports and Certification: Submit results of all tests conducted above and certification that the installation is complete and ready for checkout as specified.

3.06 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both end and at each point where the cable is administered.

B. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.7 WORK AREA

A. The Contractor shall provide a clean and orderly area to work in during system installation.

   a. The work areas shall be cleaned daily. All packing trash and other assorted junk items shall be removed at the end of each workday.

   b. Dust shall be kept to a minimum during the installation. All dust shall be removed prior to the cutover, and then again just prior to project closeout.

c. The Owner and Engineer shall have access to the work area at any time during normal working hours.

d. The Owner and Engineer have the right to stop work and seek answers to questions and concerns that may come up during the installation of the new date network.

3.08 TRAINING

A. 40 hours training by manufacturer or trainer certified by the manufacturer.

B. Training shall be spread out over the length of the warranty (Ex: 8 hours at project turnover/completion, 8 hours at 3 months, 8 hours at 6 months, 8 hours at 1 year, 4 hours at 2 years, 4 hours at 3 year)

C. Training to occur in maximum of 2 hour increments.

D. Warranty certificate and agreement shall be provided to Owner IT personnel at initial training session.

E. Provide a digital video copy of the training sessions.

F. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

G. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.

H. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

I. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.09 AS-BUILT DOCUMENTATION

A. The Contractor shall furnish the Owner two digital media devices with complete as-built manuals and drawings in an indexed PDF file format. Drawings shall be a minimum of 11”x17” engineering format. These manuals shall contain:

a. System Operating Instructions

b. System Functional Block Diagram(s)

c. System Schematic Diagram(s)

d. System Wiring Diagrams

e. As-Built Drawings of Entire System including Equipment Rack Elevations

f. Component Technical Operation Manuals

g. Component Service Manuals

h. Software Operating Manuals

i. Port and Switch Labeling

j. Final Endurance Test Report

B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

C. The contractor shall provide a new Owner network map indicating all new buildings included in this scope of work. Network map shall include equipment information, IP addresses, VLAN information, etc. Network map shall be prepared utilizing a computer drafting program such as AutoCAD or Visio, and shall be presented in electronic format.

3.10 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

3.11 CERTIFICATION

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION

27.42.19--DIGITAL SIGNAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.02 SCOPE OF WORK

A. Shall be Compatible with Apple/Mac Environment

B. Provide a complete building wide digital signage system as defined in these specifications and shown on the drawings. The system shall distribute content over the building's network to players at the display locations. The system shall include content creation software with numerous pre-made templates for use by the building. The software shall provide easy distribution of multiple channels of content, multiple schedules, emergency notification, and operate on a virtual server provided by the building. A complete system will include all components, players, software, as well as connecting cables and hardware.

C. Licenses, permits as may be applicable

D. Provision of submittal information

E. Installation in accordance with contract documents, manufacturers' recommendations and applicable codes

F. Programming and configuration of control and signal processing software

G. Testing and adjustments, including documentation thereof

H. Provision of manuals

I. Maintenance and warranty services

1.03 APPLICABLE REFERENCES:

A. National Electric Code (NEC)

B. Underwriters Laboratories (UL)

C. Sound System Engineering (Davis & Patronis) - 3rd Edition 2006

D. Audio Systems Design and Installation (Giddings) 1990

E. Telecommunications Distribution Methods Manual (TDMM)

1.04 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code.

B. Underwriter's Laboratory.

C. TIA/EIA-607 Telecommunications Grounding.

D. 11th Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).

E. American with Disabilities Act.

F. Federal Communications Commission Part 15.

G. Sound System Engineering (Davis & Patronis) – 3rd Edition 2006.

H. Audio Systems Design and Installation (Giddings) 1990.

I. The intent of these Specifications is to describe and provide for a complete Audio Visual Presentation and Sound Reinforcement System of professional quality and reliability. Professional performance standards as provided by a qualified and experienced sound systems contractor (hereafter referred to as Systems Contractor) will be required. References and documentation of the System Contractor's experience and following qualifications shall be provided, if requested.

J. The Systems Contractor shall:

   a. An authorized dealer/service organization for all major items of electronic equipment furnished.

   b. Have completed, within the past two (2) years the satisfactory installation of at least three (3) systems of similar size and type as that herein specified.

   c. Maintain a factory trained service department on call 24 hours a day, 365 days a year, to service the specified product.

   d. Employ, on a full-time basis, a qualified audio/electronics Engineer under whose direction and supervision the entire installation shall be carried out. AVIXA CTS, NICET or C-EST audio certification required.

K. Employ, on a full-time basis, technician(s) who are experienced in the installation of sound reinforcement equipment, its interconnection and setup. Qualified technicians shall perform the assembly, wiring, interconnection setup and programming of all equipment, jacks and devices. AVIXA CTS, NICET or C- EST audio certification required.

L. The Systems Contractor shall coordinate final utility rough-in locations with actual equipment furnished. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations, and all applicable code requirements.

M. In all cases, the Owner and Engineer shall determine the acceptability of the work based upon site visits and observations.

1.05 COOPERATION AND COORDINATION

A. Cooperate and coordinate as required with the other contractors who are responsible for work not included in this section.

B. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations, and all applicable code requirements.

C. Coordinate final utility rough-in locations with actual equipment furnished.

D. Provide any and all information as required or requested by the Owner, Engineer, or General Contractor in order for this work to be completed to the satisfaction of the Owner, and in the best interests of the Project. Such assistance or information shall be transmitted in writing to the requesting party in all cases.

1.06 SYSTEM WARRANTY

A. Guarantee all parts, labor and workmanship furnished under this contract for the minimum period of three (3) years from the date of substantial completion, or first formal use by the Owner, whichever is last to occur.

B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

C. Where manufacturers' warranties on certain equipment exceed twelve months, the guarantee period on that particular equipment shall match the extended warranty period.

D. Provide assistance to the Owner during the guarantee period of the system, as required to ensure maximum Owner satisfaction.

E. Upon completion of the work, the contractor shall submit a signed Certificate of Warranty, stating commencement and expiration dates and conditions of the warranty. Incremental warranties for completed portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor

1.07 SHOP DRAWINGS AND SUBMITTALS

A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30" x 42", 24" x 36" paper. Equipment lists, data sheets, etc. Shall be 8-1/2" x 11" size properly bound into a single or multiple volumes.

B. Submit to the following for approval:

   a. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item referencing the section number in Part 2 of this specification.

   b. Manufacturer's data sheets on all equipment items.

   c. System block diagram(s)

d. Equipment rack layouts showing all rack mounted equipment items.

e. Floor 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.

f. Proposed construction details for all custom fabricated items, including interface panels, patch panels, and wall plates. These details shall show dimensions, materials, finishes and color selection.

g. Riser diagrams showing conduit requirements with pull boxes, outlet boxes, part numbers of cable types used, and number of circuits in each conduit.

h. Electrical power requirements for head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with Division 26.

i. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

1.08 FINAL DOCUMENTATION:

A. All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner, four (4) sets of the following:

a. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.

b. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and codings.

c. Documentation of system performance measurements as noted elsewhere in this specification. Include diagrams or charts showing final setting of all control knobs in the system (mixers, equalizers, power amplifiers, etc.)

d. Complete equipment rack layouts showing all rack mounted equipment items.

e. Floor plans, prepared at a scale of not less than 1/8” = 1’0”, showing loud speaker locations and orientation, wall plates, rack locations and other related device locations.

f. Riser diagrams showing installed conduit with pull boxes, outlet boxes part number of cable types used, and number of circuits in each conduit.

g. Operations instructions for each major item of equipment furnished.

h. Manufacturer's warranty for each major item of equipment furnished.

i. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner’s operating personnel in the detailed step-bystep operation of the system and preventive maintenance procedures. This manual shall include descriptions of the

system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.09 RELATED WORK BY OTHERS

A. All conduits with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.

B. All 120 VAC power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The 120 VAC power to the equipment racks shall be terminated inside the racks to Sound Contractor - supplied isolated ground plug strips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using non- metallic bushings or raceways.

C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground. Shall be furnished and installed under the electrical section of Division 16. Refer to the sound system drawings for additional details.

D. Network drops provided at all digital signage display locations.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment items shall be new and unused.

B. The following sections specifically list the acceptable equipment types and items for this project. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

C. Speaker locations are shown on the drawings for bidding purposes only. The exact speaker locations, aiming points and mounting angles shall be coordinated with the Engineer and determined through the use of an acoustical modeling program and good engineering practices. Speaker aiming shall be adjusted as required after installation to provide optimal coverage and system performance.

D. Furnish an equipment rack for use in housing the equalizers, processors, power amplifiers and ancillary devices necessary to the operation of the system.

E. Heat-producing components, such as power amplifiers, shall be mounted with one 1-3/4” vent panel installed between units. Fill all other unused portions of rack front sections with matching blank panels.

F. Furnish five (5) keys for each type of equipment rack lock installed. Lock types shall be coordinated with Owner.

G. Install the required number of units, of sufficient size to accommodate the equipment specified, at the locations indicated in the drawings.

2.02 SUBSTITUTIONS

A. Products specified herein by manufacturer's name and model number are intended to establish a minimal level of quality, performance and function. Proposed substitute equipment by listed equal manufacturers shall be equal in all respects to the specified product.

B. Proposed speaker substitute requests shall additionally be supported by electroacoustic modeling data showing proposed speaker location(s)and aiming points, maximum SPL levels and evenness of coverage at key frequencies, interaction between multiple speakers and intelligibility predictions (Aicons, STI).

2.03 DIGITAL SIGNAGE – Not Applicable

2.04 SOFTWARE CONFIGURATION

A. The entire system must be accessible from a web-based user interface including server configuration, user settings, message creation, scheduling, uploading of media or any other material aspect of daily operations.

B. The system must allow the user to preview an entire signage channel layout through the web-based user Interface.

C. The system should provide method for managing expired messages and media through web interface.

D. The system should provide the ability to have prepackaged designs installed and custom design services available. Provide any information related to ongoing costs associated with this feature. These costs will be factored into the system's cost.

E. The system must not require distributed client applications (.exe) installed on the end user's machine for any aspect of the system's operation. All operations must be accessible via a standard web browser.

F. Distributable client applications (.exe) are acceptable for screen saver applications where the system provides, or has the option to provide, screen saver modules that mirror the system's display on client computers.

2.05 USER ACCOUNTS, PERMISSIONS AND SECURITY

A. Users must log on to the system using a username and password that may or may not be shared with multiple users.

B. Multiple users must be able to log in to the system simultaneously.

C. No artificial limit may be placed on the number of user accounts that may be created.

D. User rights must be configurable on a user account basis, allowing the system administrator to create accounts with varied levels of access.

E. The administrator must be able to specify, to a user account, varied levels of access to different message zones within the system. I.e. User X can only create content for zone 2. User X is unable to see or edit content for zone 3.

F. The system must provide the ability to link to LDAP to support single sign-on capability.

G. The system must be able to automatically close a session with a user after a specified amount of inactivity.

H. The system must provide notification to designated administrators when users create new messages through email and the user interface.

I. Administrators must be able to specify minimum complexity settings for user passwords.

J. Passwords must be able to be reset by an administrator.

K. System must support a “lock out” time period if a wrong password is entered more than a specified number of times.

L. Systems must allow for unlimited user accounts to be created without incurring an additional cost.

2.06 HARDWARE AND NETWORKING

A. The system must allow the players to connect to the network wirelessly (WiFi b, g, or n).

B. The system must track the status of media players and report back to the main server information regarding its status including current software version and last communication with the server. The system must be able to notify the administrator if any communication problems exist between the server and a media player.

C. During a network outage the system must be able to display the cached content on the media player until network connection is restored.

D. Each media player should cache the content locally and allow for at least 120 Gigabytes of content storage.

E. The system must be able to synchronize zones between media players.

F. Live video should be able to be incorporated into media player via HDMI, Component, Composite, or S-Video.

G. The system should include monitor control software to turn displays on and off based on a predefined schedule. This control should be available through serial control or the power saving feature of an EnergyStar complaint display.

2.07 DISPLAY CONFIGURATION

A. The system must be capable of 16x9, 9x16 and 4x3 aspect ratios in resolutions up to 1920x1080.

B. Each media player must be capable of displaying multiple messages at a time,

separated into zones within the channel.

C. The system must be able to allow message zones to be shared across multiple channels of the signage system.

D. Individual messages must be able to be shared across multiple zones.

E. The system must be expandable to multiple channels. Provide details regarding any limitations or licensing issues related to multiple channel outputs.

F. The system must be able to automatically resize messages to accommodate multiple aspect ratios in a given installation.

2.08 MESSAGE AND MEDIA

A. The Digital Signage system shall have flexible messaging options easily managed by the system's users with a wide range of media formats supported, and important features like emergency messaging and 3rd party data integration. The proposed system must meet the following specifications related to message creation and management along with supported media:

B. Message Creation, Scheduling, and Management

a. The system must provide a means of creating messages from reusable templates with a minimum of 50 preloaded templates included.

b. The system must provide a means of creating additional templates. The creating of templates must be achievable from the system's web interface without the aid of proprietary technology, such as ActiveX controls or Java applications.

c. The system must provide a means of assigning templates to specific users and specific channel outputs.

d. Messages added to the system must appear on a schedule that each user specifies.

e. The scheduling portion of the software must include a start date/time, an end date/time, the ability to exclude specified days of the week, and the ability to limit to specified periods of the day.

f. The system must provide a simple means of repeating a message with greater frequency within a zone. For example: Show this message every 3rd message.

g. The system should be able to calculate the amount of dwell time required for any given message to be read on the screen based on the amount of text entered. The system should also allow for a dwell time to be manually entered.

h. The system must be able to track the impression count of any message.

i. The system must allow for assigning keywords to messages or tags to zones within the software.

C. Media Requirements and Supported Formats

a. The system must provide the ability to add additional media content to th system through the web interface.

b. The system must be able to import and display MPEG-2 or h.264 video files.

c. The system must be able to import and display the following image formats: PNG, JPEG, BMP, and Photo Shop.

d. The system must be able to import and play the following audio formats: WMA (unprotected), MP3 and PCM WAV.

e. The system must be able to display interactive content in HTML.

f. The system must provide the capability of importing pictures from the web, and updating them at specified intervals.

g. The system must provide the ability to receive MPEG-2 or h.264 streaming video from a Windows Media Server or standards-based encoders from providers such as Visionary Solutions, V-Brick, and Vitec.

h. The system must allow for rotating of text. For example: Rotate text in a certain zone by 45 degrees.

i. The system should allow for a crawl or ticker to be rendered to the screen while not overlapping or obscuring the content.

j. The system should be able to pull content from a web page, or section of a webpage and update this content on a predefined schedule.

D. Audio Capabilities

a. The system must include the ability to replay audio.

b. The audio capabilities must include the ability to receive analog audio from an external source and to adjust this audio's volume when message audio is present.

c. The audio capabilities must include the ability to replay audio stored on the media player’s hard drive as a background audio track which accompanies the signage channel.

d. The system must allow users to assign audio clips to messages, fading the background audio out when the message's audio is played.

E. Emergency Messages

a. The system must provide the ability to create messages that interrupt the normal display messages in a zone for emergency announcements and special events. These messages must automatically override scheduled messages, returning to the scheduled messages when the emergency messages are deactivated.

b. The system must provide a simple way to take over an entire channel of digital signage with a single message, even when that channel has multiple message zones displayed at the same time.

c. The system must allow for the creation of user accounts that have direct access to these emergency zones, so that emergency personnel can override the normal display of the system without intervention from an administrator.

F. Data Driven Messages

a. The system must provide a means of displaying weather information from an external source based on zip code. Current temp, 3 day, & 5 day forecast information is the minimum requirement. Provide any information related to ongoing costs associated with this feature. These costs will be factored into the system's cost.

b. The system must provide a means of receiving news, entertainment, trivia, sports and other information from a wide variety of sources over the Internet using RSS feeds. Provide information related to costs associated with this feature, including any ongoing subscription fees that may apply.

c. The system must provide a method for displaying scheduled information from iCal, Dean Evans and Associates EMS, Resource 25, Microsoft Exchange, Microsoft Outlook, and other scheduling systems.

d. The system must provide the ability for third party systems to automatically generate content or trigger events within the system via XML or other documented interface to the system.

2.09 WIRE AND CABLE

A. All wire and cables shall be new and unused.

B. Wire not installed in equipment racks, not portable, or not installed in conduit shall be fire and plenum rated and meet all applicable codes.

C. Speaker cable: West Penn 25225 stranded 16AWG twisted pair for equipment rack internal wiring and from the equipment rack pull box to the loudspeaker drivers.

D. Microphone-level and line-level audio cable (installed in conduit, not portable): West Penn 291 stranded 22 AWG twisted pair with foils shield or approved equal.

E. Digital Media cable shall be CAT6 shielded cable approved for digital media applications.

F. All HDMI cables for sources and displays shall be the locking style.

G. Portable microphone cables: ProCo M-Series black flexible cable or equal by West Penn or Audio Technica.

H. Other equipment control cables shall be stranded wire, appropriately shielded, of gauge and number of conductors required by the manufacturer for proper operation of the system or equipment item furnished.

I. Wire and cable for all other devices shall be supplied in accordance with the recommendations of the device manufacturer and the National Electrical Code.

J. Acceptable cable manufacturers: Belden, Carol, General or West Penn.

2.10 JACK CONNECTORS AND WALLPLATES

A. All plate-mounted connectors shall be ground-insulated from the plates on which they are mounted.

B. All other jacks shall be installed on standard stainless steel finish plates. Nomenclature shall be engraved into the plate with 1/8" block letters filled with black paint. All mic jack locations shall be numbered consecutively, starting from one (1).

C. Unless otherwise specified, all jacks and connectors for the sound system shall be as follows:

a. Microphone and line input receptacles shall be 3-pin XLR-F with locking tab equivalent to Neutrik model NC3FP-1 or equal by Switchcraft or Studio 1.

b. Combination microphone/auxiliary input jack plates shall be impedance matching units suitable for interfacing one unbalanced high- or low-impedance source to a balanced low-impedance microphone preamplifier input. There shall be one ¼" 3-conductor phone jack marked "PROJ IN" and two RCA phono jacks marked "LINE IN L/R with a resistive mixing network to sum stereo line-level sources. A linear input level control will control the level of the auxiliary inputs. A "HUM CANCEL" rocker-type switch will selectively isolate the shields. A separate female XLR connector shall provide for a separate microphone input. There shall be no electrical connection between the impedance matching circuit and the microphone circuit. Provide Pro Co AVP-1V A/V interface jack plate assemblies or equal by Whirlwind or Conquest where shown on drawings.

c. Cable-end Microphone Connectors shall be 3-pin XLR equivalent to Neutrik model NC3XX or equal by Switchcraft or Calrad.

d. Remote Controls

i. Provide a remote volume control with an on/off power switch. Provide a wire cover with a key lock.

e. Furnish and install the required number of jacks and connectors as indicated on the drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

A. 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.

B. Installation shall follow standard broadcast wiring and installation practice, and shall meet or exceed industry standards for such work, with particular attention given to any installation instructions in Parts 1 and 2 of these Specifications.

C. Equipment shall be held firmly in place with proper types of mounting hardware. All equipment affixed to the building structure must be self-supporting with a safety factor of at least six. All equipment shall be installed so as to provide reasonable safety to the operator. Supply adequate ventilation for all enclosed equipment items that produce heat.

D. All overhead or wall-mounted speaker systems shall be supported from the building structure utilizing the materials and methods required by the speaker manufacturer and providing a load-rated safety factor of 6X. All required installation material and labor shall be deemed included in these specifications.

E. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable, or manufactured to UL standards.

F. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to insure that uniform polarity is maintained. Balanced audio connectors shall be wired as follows:

   a. Wire Connector Signal

   b. Black Pin #3 or Ring Lo or

   c. Red or White Pin #2 or Tip HNie ogr Pos

   d. Bare Pin #1 or Shield Ground

G. Terminate all unused inputs and outputs with proper precision-shielded resistors. Buildout or terminate all link circuits containing active components to provide proper impedance matching. Record all pad values in the final documentation.

H. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the engineer at the time of final equalization and testing. Shields of audio cables shall be grounding at one the sending end only of the various active interconnected equipment items in the system.

I. Route cables and wiring within equipment racks and cabinetry according to function, separating wires of different signal levels (video, microphone level, line level, amplifier output, 120VAC, intercom, control, etc.) by as much physical distance as possible. Neatly arrange and bundle all cables loosely with plastic cable ties. Cables and wires shall be continuous lengths without splices.

J. All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat shrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.

K. All cables in conduits shall be insulated from each other and from the conduit the entire length and shall not be spliced. All cables and wires are to be continuous lengths without splices.

L. All solder joints and terminations shall be made with rosin-core silver solder.

M. Temperature regulated soldering irons rated at least 60 watts shall be used for all soldering work. No soldering guns or temperature unregulated irons shall be used.

N. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts will not be accepted except in the case of distributed, constant-voltage speaker systems.

O. Each mechanical connector shall be attached using the proper size controlled-duty cycle ratcheting crimp tool that has been approved by the manufacturer of the connectors. Conventional non-ratcheting type crimping tools are unacceptable, and shall not be used on the job site.

P. Label all wires in racks and at consoles as to destination and purpose. Clearly and permanently label all jacks, controls and connections with permanent engraved laminated plastic labels or by engraving and filling mounting plates, unless otherwise noted. Attach laminated plastic labels with contact cement. Embossed or printed label tape, and press- on or lift-off lettering systems will not be accepted. All labeling shall be completed prior to final system inspections. If permanent labels cannot be furnished prior to final system inspections, temporarily label all controls with write-on tape.

3.02 GROUNDING

A. Ground active components, equipment cabinets and audio line shields to independent audio system ground and to ground buss in the power panel.

B. Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from sound system, including audio equipment cabinets and audio system ground.

C. Insulate all conductors, including shields, from conduit, backboxes and from each other for the entire conduit length.

D. Take such precautions as may be necessary to prevent and guard against electromagnetic and electro-static hum and to install the equipment so as to provide normal and reasonable safety for the operator.

3.03 TESTS AND ADJUSTMENTS

A. The completed sound system is to be inspected and tested for compliance with the specifications.

B. The testing and equalization work shall be performed after the installation work has been completed, but prior to any use of the system.

C. The process of equalizing and testing the system may necessitate moving, adjusting or re- aiming certain loudspeakers. Adjustments shall be performed without claim for additional payment.

D. Coordinate as necessary to ensure a totally quiet room during the sound reinforcement systems testing and balancing period.

E. Tests - Prior to requesting systems acceptance testing, verify the following tests have been performed and the results documented. Record the results in the final project documentation.

   a. Polarity Test: Using a polarity checker, ensure that all input and output connections are consistent with regard to polarity.

   b. Absolute Impedance:

      i. With loudspeaker level controls at zero attenuation and amplifiers disconnected, measure and record the absolute impedance value of each loudspeaker line at 250,1000 and 4000 Hz. For band-limited devices, use a frequency appropriate for the operating range of the transducer. Impedance shall be at least 90% of rated load impedance of respective amplifier. Correct any field readings that differ by more than 20% of the calculated impedance.

      ii. Check and record resistance of all lines to input receptacles, with receptacles open and short-circuited.

   c. Parasitic Oscillation and RFI Pickup

      i. Set up system for each mode of operation.

      ii. Use 5MHz bandwidth oscilloscope and loudspeaker monitoring.

      iii. Check to ensure that the system is free of spurious oscillation and RF pickup in the absence of any input signal and also with the system driven momentarily at full output at 160 Hz.

   d. Buzzes, Rattles and Distortion

      i. Apply a high-quality music signal to the system. Adjust for frequent peaks at the specified system maximum sound pressure level.

      ii. Apply a sinewave sweep from 30-5,000 Hz at 6 dB below full amplifier power.

      iii. In both cases, listen carefully for buzzes, rattles, and objectionable distortion.

      iv. Correct all causes of such defects. If a cause is outside the system, promptly notify the Engineer of the cause and suggested corrective procedures.

F. Setup and Adjustments

a. Gain Structure: Adjust input sensitivity and output levels of interconnecting active devices in each signal chain for maximum headroom and signal-to-noise ratio. All devices in each signal chain should clip at the same time as gain is increased. Record electrical levels between all active devices.

b. Equalization

    i. Measure system acoustical performance using a calibrated sound level meter set for "slow" meter damping and flat response with random incidence. All interior furnishings shall be in place and system gain shall be adjusted to provide levels of 70 to 80dB and at least 20dB above ambient noise levels at the measuring locations.

    ii. Using a precision calibrated 1/3 octave audio frequency analyzer and filtered pink noise, with all control equalization set for flat response, measure and record loudspeaker frequency response in 1/3-octave bands. Measurement microphone shall be placed on-axis to the pertinent speaker, in the center of each seating area.

    iii. Adjust equalization to provide average system response within +1-3 dB of a response curve that is flat from 300-3000 Hz then sloped uniformly to -4dB at 12KHz. Record both equalizer settings and analyzer curves.

c. Amplifier Level Adjustment: Adjust the level of each system to achieve a volume level appropriate for the location and intended use. After setting the amplifier level for each system, use a pink noise input signal and a sound level meter to identify any areas where the SPL changes by more than 3dB. Identify the cause of the level discrepancy and correct the problem by adjusting amplifier levels or speaker taps. Record the amplifier settings in the final project documentation.

d. Assistive Listening frequency selection shall be coordinated with other assistive listening systems in the same or adjacent facility so as to avoid interference and cross talk between separate systems. Each discrete system consisting of a transmitter and associated receivers shall be set to operate on its own select frequency.

G. Should the performance testing show that the Contractor has not properly completed the systems, the Contractor shall make all necessary corrections or adjustments, and a second demonstration shall be arranged at the Contractor's additional expense.

3.04 SYSTEMS ACCEPTANCE TESTING AND TRAINING

A. A qualified technical representative of the System Contractor shall do systems acceptance testing. Installation must be complete in all respects before acceptance testing. Acceptance testing and training must be scheduled on separate dates to allow time for corrections, if necessary. Once all functions and devices within the system have been adequately demonstrated to be working properly,

a complete Owner's Manual will be presented to the Owner's agent. It shall contain a comprehensive list of all supplied equipment, a complete point-to-point system wiring diagram with "as-built" wire numbers indicated, details of hook-up connections including build-out devices (active and passive), systems control settings record, the final test results including plotted frequency response curves, operation and maintenance manuals for each active device including schematic diagrams and parts list.

B. The contractor shall ensure that test equipment is on site during the testing period. He shall provide a listing of the specific equipment to be made available, prior to the testing appointment. The following minimal standard test equipment shall be provided:
    a. Oscilloscope - 10 MHz bandwidth
    b. 1/3 Octave real time analyzer
    c. Three-dimensional, FFT-based measurement system (TEF, Smart, SIM II, WINMLS, etc.)
    d. Calibrated microphone with portable mic cord of sufficient length to reach all speaker measurement locations
    e. Broadband random noise source
    f. Low distortion sweepable sine wave generator
    g. Distortion analyzer
    h. AC impedance bridge
    i. Sound level meter: Class 2 filters per ANSI S1.4; range 40 to 120 dBA
    j. True RMS Multimeter- Minimum range: DC to 20kHz, 1OOmV to 300V, 1Oma to 10A.
C. The Contractor shall be prepared to verify the performance of any portion of the system by demonstration, listening tests and/or instrument measurements.
D. Acceptance tests may include speech intelligibility surveys and subjective evaluations by observers listening at various positions under various conditions using speech, music, and live or recorded program material.
E. The Contractor shall make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Architect/Engineer as a result of acceptance tests.
F. Test Reports and Certification: Submit results of all tests conducted above and certification that the installation is complete and ready for checkout as specified.

3.05 TRAINING

A. Training of owner's personnel shall be done by the Contractor. The Owner and/or his designated representative shall be fully advised as to the function of all operating controls and in techniques necessary to ensure proper operation of the entire system. The training session may include more than one trainee. If possible, several people should be trained. It may be necessary to return for

another session, possibly during an actual use of the system. Provide a minimum of (8) hours of instruction and familiarization for this purpose.

B. The Engineer or his representative will participate during the training period.

C. The training phase shall be accompanied by complete as-built documentation and the custom Technical System Operation manual. Review of the owner's manual and demonstration of all systems functions is required.

D. Video record all training and provide digital copy to Owner.

3.06 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

27.51.19 - SOUND MASKING SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Sound Masking Systems: Performance based specification for networked based systems including but not limited to the following.

1. Digital signal processors.
2. Noise generators.
3. Paging interfaces.
4. Amplifiers.
5. Loudspeakers.
6. Associated wiring, controls, supervised signals, lines, and components.

1.02 REFERENCES

A. American Disabilities Act (ADA):

B. American National Standards Institute (ANSI):

1. ANSI S1.4 - American National Standard Specification for Sound Level Meters.
2. ANSI S1.6 - American National Standard Specification for Preferred Frequencies and Band Numbers for Acoustical Measurements.
3. ANSI S1.11 - American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.
4. ANSI 709.1 - ISO / IEC Standards for Open Platform.

C. ASTM International (ASTM):

1. ASTM E1374 - Standard Guide for Open Office Acoustics and Applicable ASTM Standards.
2. ASTM E1573 - Standard Test Method for Evaluating Masking Sound in Open Office Using A-Weighted and One-Third Octave Band Sound Pressure Levels.
3. ASTM E1130 - Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index.
4. ASTM E1041 - Standard Guide for Measurement of Masking Sound in Open Offices.

D. Underwriters Laboratories (UL):

1. UL 1310 - Standard for Class 2 Power Units.
2. UL 1480 - Speakers for Fire Alarm and Signaling Systems, Including Accessories.
3. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

4. UL 2572 - Standard for Mass Notification Systems.
5. UL 6500 - Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial, and Similar General Use.
6. UL 60065 - Standard for Audio, Video and Similar Electronic Apparatus - Safety Requirements.
7. UL 60950 - Information Technology Equipment - Safety.

1.03 SUBMITTALS

A. Submit under provisions of Section 01.30.00 - Administrative Requirements.

B. Proposal:

1. A preliminary listing of proposed major components, in the order and format listed in the products section of these performance specifications, along with the manufacturer's detailed technical data sheets. Advertising literature shall not be accepted.

C. Product Data:

1. Manufacturer's data sheets on each product to be used.
    i. Submit in PDF format.
    ii. Equipment data sheets will be identified with device IDs that reference drawings and equipment used.
2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Typical installation methods.

D. Layouts shall be submitted for approval on the following:

1. Loudspeaker system locations.
2. Plenum mounted networked masking noise components.
3. Equipment rack layouts.

E. Test results shall be submitted for approval of the following, as specified herein:

1. 1. Performance tests on completed component sub-assemblies.
2. 2. Performance tests on the complete system assemblies.

F. Shop Drawings: Include details of materials, construction, and finish. Include relationship with adjacent construction.

1. Submit in DWG format for approval on all items that require assembly by the Installer, including, but not limited to:
    i. Headend Rack panel layouts.
    ii. Loudspeaker enclosures.

iii. Supporting brackets for the suspension and/or support of loudspeaker enclosure and equipment enclosure.

iv. Wiring and installation diagrams showing quantity and location of system components and related cabling and accessories.

G. Within the scheduled number of days after receipt of Notice to Proceed, the installer will submit the following for approval.

1. Complete components list, in order and format in the contract documents. For proposed substitutions to components listed in this performance specification, manufacturer's independent test data to demonstrate performance specification compliance will be provided.
2. Complete and final list of components to be furnished, in the same order and format as the specifications, with conforming manufacturers' independent test data for each specified item. Furnish a brochure and photograph (unless included in the brochure) of each item.

1.4 SYSTEM DESCRIPTION

A. Broad band (65 Hz to 20 kHz) background noise in open plan and partitioned work areas.

B. When Used in Conjunction with Proper Ceiling and Partition Construction:

1. Limits Speech Intelligibility: Providing privacy between work areas.
2. Reduces disturbing effects of noise caused by other common office activities i.e., keyboards, printers, etc.

C. Octave Band Sound Pressure Level Spectrum:

1. Octave Band (Hz): 200.
   i. Level (dB) Open Areas: 2.5.
   ii. Level (dB) Enclosed Office: 2.
2. Octave Band (Hz): 250.
   i. Level (dB) Open Areas: 3.
   ii. Level (dB) Enclosed Office: 2.
3. Octave Band (Hz): 315.
   i. Level (dB) Open Areas: 2.
   ii. Level (dB) Enclosed Office: 1.5.
4. Octave Band (Hz): 400.
   i. Level (dB) Open Areas: 1.
   ii. Level (dB) Enclosed Office: 1.
5. Octave Band (Hz): 500.

i. Level (dB) Open Areas: 0.

ii. Level (dB) Enclosed Office: 0.

6. Octave Band (Hz): 630.
   i. Level (dB) Open Areas: Minus 1.
   ii. Level (dB) Enclosed Office: Minus 1.
7. Octave Band (Hz): 800.
   i. Level (dB) Open Areas: Minus 2.
   ii. Level (dB) Enclosed Office: Minus 2.
8. Octave Band (Hz): 1000.
   i. Level (dB) Open Areas: Minus 3.
   ii. Level (dB) Enclosed Office: Minus 3.
9. Octave Band (Hz): 1250.
   i. Level (dB) Open Areas: Minus 4.
   ii. Level (dB) Enclosed Office: Minus 4.5.
10. Octave Band (Hz): 1600.
    i. Level (dB) Open Areas: Minus 5.
    ii. Level (dB) Enclosed Office: Minus 5.
11. Octave Band (Hz): 2000.
    i. Level (dB) Open Areas: Minus 6.
    ii. Level (dB) Enclosed Office: Minus 6.

D. Spectrum: Will have relative 1/3 octave band levels which form a smooth spectrum within the constraint of the above octave band values and are within 2 dB in the 400 to 2000 Hz bands and to within a slowly increasing limit for higher and lower bands to a maximum variance of 6 dB in the 63 Hz and 8000 Hz bands.

E. Nominal Sound Level in dBA for Each Area:
   1. Conference Rooms: 42 dBA.
   2. Enclosed Offices: 44 dBA.
   3. Semi-Enclosed Workstations: 45 dBA.
   4. Open Office Areas: 47 dBA.

F. Background Noise Level Must Exhibit Temporal Uniformity. The short-term time average level of each 1/3 octave band over any selected 2 second interval is to vary no more than 3 dB with respect to the long-term average.

G. In Open Areas and Larger Enclosed Spaces: Overall sound level produced to have spatial uniformity of plus or minus 1 dB between any two sound generating units.

1.05 SCOPE:

A. The terms 'Masking Noise System Installer' or 'Installer' refer to the organization providing and installing the masking noise system.

B. Masking Noise System Installer will be Responsible for the Following:

1. Make system operational.
2. Furnish and install system components within space provided by others.
3. Demonstrate by appropriate test data system meets performance specifications.

C. C. Installer Responsibilities:

1. Obtain and be familiar with drawings and details for the masking noise system.
2. Furnish and install the following:
   i. Wiring and cabling.
   ii. Masking noise equipment and materials per contract documents.
   iii. Support brackets for suspension of loudspeakers.
   iv. Seismic bracing per applicable building codes.
   v. Furnish items for mounting, terminating, matching, and connecting elements per the contract documents. Additional items required to meet system performance requirements including installation labor, to be supplied by the Installer.
   vi. Furnish and install equipment, solid state devices, power supplies, transformers, matching networks, signal indicators, controls, mounting brackets, painting, devices, and other materials even though not specifically mentioned herein, which are necessary for the proper integration of the system, so that the system performs the functions listed herein in compliance with the contract documents.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum ten years documented experience.

B. Installer:

1. Qualifications:
   i. Experienced in design, fabrication, installation, checkout, and warranty contract management of systems such as is described in this section.
   ii. Must be factory qualified and certified to install the products listed in this performance specification.

2. Responsibilities:
    i. Responsible for system specified and be the single contact point for the Architect, Consultant, Fire Protection Engineer (FPE) and/or the Owner with respect to sound masking Work specified.

C. Manufacturer's Project Engineer:
    1. Qualifications: Five years' experience with similar electronic specialty systems, or other educational experience background as approved by Architect and Consultant.
    2. Responsibilities: Obtain and be totally familiar with drawings that have a bearing on the location and installation of electronic equipment, loudspeakers, or any special components.

D. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.

E. Equipment and associated hardware to be fabricated and installed in accordance with the manufacturer's specified recommendations.

F. Unless otherwise stated, electrical and electronic equipment will be products of established manufacturers with a minimum of 10 years manufacturing sound masking systems. Use the latest models or types which meet the applicable specifications at the time of submittal.

G. Quality of workmanship and fabrication of equipment and components which are custom fabricated to be comparable to professional audio equipment as produced by specialized manufacturers of electronic apparatus. Only skilled craftsmen of the profession required are to be utilized for all aspects of system fabrication and installation.

H. Materials and Products: New and of the finest quality. No used materials to be installed.

I. System Design: By an approved manufacturer representative.
    1. Designed so that individual speaker or component failure will have no impact on the balance of the system.

J. System Adjustment: Completed by an approved manufacturer representative or trained contractor.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver in manufacturer's original unopened and undamaged packages with manufacturer's labels legible and intact.

B. Store and handle in strict compliance with manufacturer's written instructions and recommendations. Protect from moisture during shipping, storage, and handling.

C. Protect from damage due to weather, excessive temperature, and construction operations.

D. Inspect manufacturer's packages upon receipt.

1.08 WARRANTIES: ALL EQUIPMENT

A. Warranted to be free from defects in materials, workmanship, and performance for minimum of 3 years from date of installation.

1. At Closeout, provide to Owner an executed copy of manufacturer's standard limited warranty against manufacturing defects, outlining terms, conditions, and exclusions from coverage.

1.09 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 recommended limits.

PART 2 - PRODUCTS

2.01 SOUND MASKING SYSTEMS

A. Basis of Design: i.Net non-network as manufactured and supplied by Lencore Acoustic LLC (or equivalent). Masking, music, and paging.

B. Design of the sound masking system will be customized and supplied as required to meet the performance and design requirements per this specification.

2.02 PERFORMANCE REQUIREMENTS

A. Compliance Listings or Approvals from a Nationally Recognized Testing Laboratory (NRTL):

1. UL - Underwriters Laboratories, Inc.
2. ULC - Underwriters Laboratories Canada.
3. ETL - Intertek.

B. System Architecture: Networked decentralized with addressable masking devices distributed throughout the installation area.

C. Regulatory Testing and Certifications:

1. 1. Relevant System Components Conforming to Following:
    i. Safety and Electrical: UL 6500 - Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial and Similar General Use. Products shall be labelled accordingly.
    ii. Air-Handling Plenum Installation: UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; 1996. Products shall be labeled accordingly.
    iii. Plenum Rated Cabling: CSA CMP 75C FT6. Products shall be labelled accordingly.
    iv. Electromagnetic Interference (EMI): FCC - Part 15, Subpart B, Class A - Unintentional Radiators.

v. Heavy Metals: RoHS - Restriction of Hazardous Substances.

vi. Low Voltage Power Supplies: UL1310 - Standard for Class 2 Power Units. Products shall be labeled accordingly.

vii. UL 2572 - Standard for Mass Notification Systems.

D. Sound Masking Performance: Digital signal processing (DSP) technology for masking sound generation and output adjustment of masking signals.

1. Masking Sound: Generated via a truly random, non-deterministic digital process with no repeat cycle within a 24-hour period.

2. System Requirements:

i. Single control unit/panel (SMCP): Capable of addressing entire system. Multiple control units not acceptable.

ii. Integrated Sound Masking Digital Signal Processors (DSP's): Utilize an open platform network technology, meeting open control standards with web appliances, browser interfaces, infrared remote controls, and internet access capable.

iii. Capable of separately and independently configuring zones for sound masking via the network zoned through its singular central control.

iv. Control System: Capable of using RS232 for intelligent building integration.

v. Standards for Open Platform: Meet ANSI 709.1 / ISO / IEC.

vi. US Army Corp.'s Unified Facilities Guide Specifications:

1. 1) UFGS 25 10 10, "Utilities Monitoring and Control System."

2. 2) UFGS 23 09 23, "Direct Digital Control for HVAC and Other Local Building Controls."

vii. Multi-drop network system, point to point systems are unacceptable, no exceptions.

viii. System Tuning: Through a network or hand-held remote or keypad switches.

ix. Complete diagnostics capability of entire system functions including diagnostics of network, hubs, nodes, routers, DSP, Relays, memory, circuitry, amplifiers, and power.

x. Report entire settings for each zone indicating at a minimum the volume, contour, equalization, diagnostics, and zones and channel groupings.

xi. Diagnostics and remote administration via a standard web browser.

xii. Capable of naming network nodes, channels, zones, and external audio sources via its integrated Graphical User Interface.

xiii. Equalizer: 30 band parametric or 30 band third-octave compliable via DSP.

xiv. Speakers: 4 to 6-1/2-inch (102 to 165 mm) diameter ensuring delivery of a broad frequency spectrum.

xv. Line Interfacing with Fire Alarm Control Unit (FACU) and Sound Masking Control Unit (SMCU): Monitor as defined by UL 2572.

3. Programmable function to gradually ramp up masking volume at a predetermined schedule.

E. System Control: Control Panel Component Provide Controls for:

1. Networked device addressing.
2. IP setup for controller.
3. Administration for User Profiles:
   i. Controller must capture and report all changes any user makes to the system.
   ii. Password Protection: Admin and user profiles.
4. System compatible with third party controllers.
5. Work with BACnet or Modbus systems.
6. Setup and Configuration:
   i. Initialization.
   ii. Harvesting and uploading all settings.
   iii. Masking volume and contour adjustment.
   iv. Masking equalizer adjustment.
   v. Audio Source equalizer adjustment.
   vi. Labeling all nodes, channels, zones, and custom EQ settings.
   vii. System independent zoning for masking.
   viii. System independent zoning for paging.
   ix. System independent zoning for audio input.
   x. Masking timer programming.
   xi. Security functions.
   xii. System diagnostics and monitoring.
   xiii. Graphical User Interface address books for multiple buildings on a campus.
   xiv. Interfacing with the Fire Alarm Control Unit (FACU).
7. System control for the entire building or buildings by providing operation of multiple system components from a single central location.
8. Lockouts preventing simultaneous adjustment of system from multiple users.
9. Defer control to Fire Alarm Control Unit (FACU) in event of a fire emergency for muting the masking through the Sound Masking Shutdown Sequence.

F. Network Device Discovery:

1. Identify networked masking devices via an automatic addressing process such that devices that are numbered in sequence based on their location in the network on each floor.
2. Identified Masking Device: LCD screen display in addition to labels for ID of devices.
    i. Work with network controller ensuring proper display of ID.
    ii. Work real time to display any changes.
    iii. c. LCD display for error messages.
3. System should leverage analytic software, working in real time, to manage and monitor system performance.

G. Scheduler: Control components providing and integrated masking timer function:
1. Automatic masking volume adjustments per custom user-programmed schedules.
2. Ability to digitally assign any group of masking zones to a selected timer zone.
3. Calendar-based operation.
4. Automatic and user-defined daylight savings adjustment.

H. Zoning: Networked masking devices zone capable for masking, paging, and external audio.
1. Zoning of networked masking devices performed digitally.
2. Zone assignments to each type to be independent of each other.
3. Networked masking devices capable of individual rezoning without rewiring.
4. Each zone capable of holding, at a minimum 10 programmable zone assignments.

I. Cabling: Single category-based cable providing, control signals for connections between:
1. Control panel components and networked masking devices.
2. Networked masking devices.
3. Nodes and speakers, and speaker to speaker connections.
4. Monitored and Supervised Line per UL 2572.
    i. Connection to Fire Alarm Control Unit (FACU) from a single Sound Masking Control Unit (SMCU).
5. System Power: Run on a separate dedicated cable.
6. Cabling: Rated for air-handling plenums.
7. Cabling Connections: Made using connectors with positive locking mechanisms.
8. Cables: Non-proprietary off the shelf cables. Single source cables are unacceptable.

J. Diagnostic: Upon initial configuration.

1. Automatically detect number and type of networked devices connected.
2. Verify networked devices are communicating with other devices on the network.
3. Verify networked devices are initialized.
4. Identify networked devices not communicating.
5. Verify system design integrity.

K. General Requirements:

1. Masking Noise Equipment: UL listed.
2. Equipment Installed Above Ceiling: UL listed plenum rated.
3. Electrical Equipment: Products of established manufacturers.
    i. Sustained proper operation at a nominal 120 VAC plus or minus 10 percent, 60 Hz, plus or minus 10 percent power source.
    ii. No exposed, unprotected 120 VAC potential inside or outside any enclosure. Exterior metal surfaces to be grounded.
    iii. Sustained proper operation within temperature range of 32 to 104 degrees F (0 to 40 degrees C).
    iv. Quality of workmanship and fabrication of custom fabricated equipment to be comparable to professional audio equipment as produced by specialized manufacturers of electronic apparatus.
    v. Designed or adaptable for standard front panel rack mounting.
    vi. Manufacturers' stock equipment and component labeling and console designations to be in English. Systems nomenclature, signage and custom labeling pertaining to routine system operation shall be on the equipment itself and on descriptive drawings, charts, or diagrams.
4. Equipment to be selected with the criteria of operational simplicity and ease of maintenance.

L. Masking Noise Processor:

1. DSP-Based Masking Sound Generator: Provides noise generation, equalization, and level control for the system.
2. Global and Local Level Sound Zoning: Designed per space plan for areas requiring special attention, i.e. patient rooms, exam rooms, reception areas, provider offices, clerical work areas, open areas, patient check in areas, special work areas, executive areas. Zoning must allow both volume and frequency adjustments.
3. Software Configurable and Controllable: Programming sound pressure level at predetermined times.
4. Control Unit:

i. LON or BACNET capable.
ii. Digital input/output relays.
iii. TCP IP and RS-232 port.
iv. Control entire building without any additional controllers.
v. Browsed using off the shelf software.
vi. Email reports.
vii. Programming alarms, alarm triggers.
viii. Data logs creation.
ix. Listed UL 2572 by a nationally recognized testing laboratory (NRTL).

5. Noise Generator: Octave bands from 20 Hz to 20 KHz.
   i. Voltage: 48 Volts DC, 60 Hz.
   ii. Contour adjustments.
   iii. Spectrum Adjustment: Meet acoustical preferred curve.
   iv. Octave Band: 1/3 band EQ for entire spectrum (20 Hz to 20 KHz). Meets ANSI specification for bands.
   v. Parametric EQ for entire spectrum: 20 Hz to 20 KHz.
   vi. Central volume control, contour control and EQ control for zones for sound masking.
   vii. Central volume control, and EQ control for zones and units for paging and audio.
6. Power Supply:
   i. Output:
      1. Voltage: 48 VDC.
      2. Rated Current: 3.2 A.
      3. Current Range: 0 to 3.2 A.
      4. Rate Power: 150, 320, 500 W.
      5. Output Voltage Adjustment Range: 45.6 to 52.8 V.
      6. Line Regulation: Plus, or minus 0.5 percent.
      7. Load Regulation: Plus, or minus 0.5 percent.
      8. Setup, Rise Time: 600 ms, 30 ms at full load.
      9. Hold Up Time: 20 ms at full load.
   ii. Input:
      1. Voltage Range: 85 to 264 VAC. 120 to 370 VDC.
      2. Frequency Range: 47 to 63 Hz.

3. Power Factor: Greater than 0.93/230 VAC. At Full Load: Greater Than 0.98/115 VAC.
4. AC Current: 2.5 A at 115 VAC and 1.2 A at 230 VAC.
5. Inrush Current: Cold Start 40 A at 230 VAC.

iii. Safety and EMC:

1. Safety Standards: UL60950-1, TUV EN60950-1 and S-Mark J60950 Approved.
2. Harmonic Current per EN61000-3-2, -3.
3. EMS Immunity per EN61000-4-2,3,4,5,6,8,11; ENV50204, and EN55024.

iv. Environment:

1. Working Humidity: 20 to 90 percent RH non-condensing.
2. Working Temperature: Minus 10 to 60 degrees F (minus 12 to 15.5 degrees C). Refer to output load derating curve.
3. Storage Temperature and Humidity: Minus 20 to 85 degrees F (10 to 95 percent relative humidity)
4. Temperature Coefficient: 0.05 percent at (0 to 50 degrees C).
5. Vibration: 10 to 500 Hz, 2G 10 min per cycle, 60 min each along X, Y, Z axes.

v. Others:

1. MTBF: 191.2K hrs. min. per MIL-HDBK-217F 77 degrees F (25 degrees C).
2. Dimensions: 7-27/32 x 3-29/32 x 1-15/16 inches (199 x 99 x 49 mm).

vi. Protection:

1. Overload: 105 to 150 percent rated output power.
2. Protection Type: Constant current limiting, recovers automatically after fault condition is removed.
3. Over Voltage: 52.8 to 64.8 V.
4. Over Temperature: 194 to 212 degrees F (90 to 100 degrees C).

vii. TSW1: Detect on heat sink of power transistor.

1. Protection Type: Shut down o/p voltage, recovers automatically after temperature goes down.

M. Loudspeaker Systems:

1. Product Specifications: Meet or exceed.

i. Speaker Type: I.Net Pendant/Inline Speaker, White or Black.

ii. Size: 5-1/4 inch (133 mm) wide dispersion.

iii. Power Rating: 10 Watts Root Mean Squared (RMS).

iv. Frequency Response: 65 to 12,000 Hz.

v. Pressure Sensitivity: SPL at 1 Watt per m: 90 dB.

vi. Impedance: 32 Ohms.

vii. Magnet Weight: 10 oz (283.5 grams) minimum.

viii. Sound Volume from 1 Watt Input at Meter: 86 dB

ix. Impedance: 32 Ohms.

x. Listed: UL1480.

N. Remote Central Volume Control:

1. Generation and integration of multiple random sound masking sources. Channel outputs with three levels of global and independent control.

i. Contour Control: At source using infra-red technology for each independent channel, quad-pod, and global control or via a centralized control.

ii. Parametric Equalization Control: For one to 6,400 speakers.

iii. Third Band Octave Controls: Same as parametric controls for groups.

iv. Volume Control: For entire spaces, to channels, to individual speakers.

O. Programmable Audio Level Control:

1. Standard Applications: Scheduling, data logging, alarm detection and dispatch, meter reading, analog functions, and type translation.

i. Scheduling Application: Permits events and exceptions to be initiated based on time and date schedules configured by the user.

ii. Astronomical Position Calculator: Permits scheduling to be done based on calculated position of sun.

iii. Data Logging Application: Collects network activity for use by trending, reporting, and analysis applications.

iv. New DIME Support: Enables data log upload to a Web services application to occur through a firewall.

v. Alarming Application: Provides a means to identify, annunciate, and log alarm conditions.

vi. Meter Reading Application: Supervises impulse meters and provides suitable conversion values for energy, gas, and water metering.

vii. Automatic Sound Power Level Changes: Two system channel changes, four times per day, and capable of different time settings for each day of the week.

viii. Programmable Attenuation Range: Minus 24 to 24 dB (48 dB).

ix. Slide Control Attenuation Range: Minus 24 to 24 dB.

x. Minutes per dB Change: User programmable.

xi. Acclimation Attenuation Range: Minus 24 to 24 dB.

xii. Acclimate Days per dB Change: 1 to 5 days.

xiii. Programmable Events: 24 events per day for each zone.

2. Sound Masking, Shutdown Sequence:

i. The FACU and associated supervised lines to meet UL 2572 ensuring the shutdown mechanism is properly supervised and is reliable and will in no way damage the FACU or SMCU.

ii. The FACU and associated relays must not introduce any noise into the sound masking, system.

3. Non-UL listed SMCU is not acceptable.

4. Program Memory: Nonvolatile for one year, minimum, without power. When re-energized after a power outage, control starts at zero level and automatically advances system sound level at same rate used for programmed level changes.

P. Miscellaneous Equipment:

1. Wiring and Cables:

i. Use manufacture recommended cable.

ii. Grounding Wire per NEC 800-31 (1984) and NEC 250.

iii. Lacing and Clamping: No intermediate splices are permitted.

iv. Connections: Soldered. No solderless connectors or "wire-nuts" for splicing or connections.

2. Equipment Racks: By others. Coordinate with IT.

3. Conduit System: Meet requirements of metallic conduit system described in electrical specifications, Division 26.

Q. Aids-To-Use:

1. One Durable Single Line Block Diagram: Drawn for the purpose of facilitating the operator's use of the system.

i. A simplified block diagram mounted inside the front of equipment enclosure panel.

ii. Equipment, controls, etc., to be identified as they are designated or engraved.

iii. No superfluous information such as wire designations, voltages, levels, construction information, etc., is to appear.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly constructed and prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect in writing of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Obtain necessary permits for installation Work.

3.03 INSTALLATION

A. General: Install in accordance with manufacturer's instructions approved submittals and in proper relationship with adjacent construction.

1. The following installation requirements govern the installation of systems specified. In cases of discrepancy between overall system standards and individual equipment item specifications, the latter will govern.
    i. Workmanship on the installed system shall be of professional quality, best commercial practice and accomplished by persons experienced in the techniques and standards of the particular crafts involved.
2. Equipment items shall be provided and installed to allow fully normal operation in the anticipated ambient temperature range of 60 degree-90 degree
3. Any Work called for on the Drawings and not mentioned in the specifications, or vice versa, will be performed as though fully set forth in both.
    i. In Case, of Differences Between the Drawings and Specifications: The decision of the Sound Masking Professional responsible for the Sound masking equipment and installation will govern.
    ii. Work not Particularly Detailed, Marked, or Specified: Will be construed to be the same as similar parts or areas that are detailed, marked, or specified.

B. Equipment Enclosure Layout and Assembly:

1. Equipment Enclosure: Installed in the equipment room. Install as shown in the drawings.
    i. Constructed to easily accommodate interconnecting cables entering from above or below.

ii. Provide approved terminal blocks. Other suitable means of terminating or connecting incoming and outgoing cables may be used if approved by the Sound Masking Professional responsible for the Sound masking equipment.

2. Interconnecting Cabling: Will be led laterally from each component to the vertical rack member opposite from the AC power strip and then run vertically, remaining as exposed and accessible as possible. Wherever corners in cabling occur a strain relief spiral covering should be used. All cable clamps shall be non-conducting or have soft insulating covers.
3. Keep low level signal lines separated from the AC power lines and high-level signal lines. This must be observed in rack layout and mechanical support or passage within the equipment room.
4. Connections of Lines at Terminal Strips: Mechanically secured and soldered. No unsoldered connections permitted. Lines approach enclosure and terminal strips to be mechanically anchored at enclosure with sufficient slack length to avoid strain, abrasion, or wear.

C. Wiring and Cabling:

1. Wiring: Executed per equipment manufacturer's wiring recommendations. Variations from these requirements, require the prior approval of the Engineer.
2. Wiring Method: Per local electrical codes. Conceal cable in accessible ceilings, walls, and floors. No exposed cable is allowed.
3. Pulling Cable: Do not exceed manufacturers recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between normal termination points. Remove and discard cable where damaged during installation and replace it with new cable.
4. Cables to be grouped and bundled by type and level and routed from source to termination in a uniform manner throughout equipment housings. Do not break the insulation or deform the cable by harness supports. Cables are not to change relative position in a cable group throughout a cable route.
5. Power distribution wiring will not be installed adjacent to signal cables. Power distribution cabling will be on the opposite side from signal wiring in equipment enclosures and uniformly located throughout an installation.
6. Edge protection material ("cat track") installed on the edges of holes, lips of ducts or any other point where cables or harnesses cross metallic edges.
7. Audio and control cable ends to be neatly formed and shrinkable tubing applied where necessary to secure the insulation against graying or raveling.

8. Conductors, including spare conductors, which are entering or leaving the above listed components, to be directly terminated on terminal blocks without intermediate splices. Terminals to be properly and completely labeled.
9. Cable Shields: Terminated in the same manner as other conductors. The shields of cables shall be kept well separated from each other and from ground.
10. Cable Installation: Responsibility of Installer for the Sound Masking system.
11. The connection to the Fire Alarm Control Unit (FACU) will be provided by the Installer to the Fire Protection Engineer (FPE).
    i. The FPE will be responsible for the physical connection to the FACU.
12. Plenum Loudspeakers:
    i. Mount loudspeakers at locations shown on approved shop drawing.
    ii. Mountings and Loudspeakers:
        1. Suspend from slab above by chain. Where possible, the bottom, of speakers to be 6 to 8 inches (150 to 200 mm) above the acoustical ceiling tile.
        2. Hang at a uniform height ensuring sound uniformity when system is on.
        3. Safety cable attached to the deck above at each loudspeaker location.
        4. If the alternate to furnish exposed loudspeaker cables in the ceiling plenum is exercised, locate cables approximately 12 inches below the metal deck and attach cables by approved J-Hook fasteners.
        5. Loudspeaker cables shall not be permitted to lay on ceiling suspension members or the ceiling tile.
13. Power Distribution Throughout the System: Per applicable codes:
    i. Unless otherwise specified, Installer will supply and install the rack mounted power distribution panel, specified elsewhere, in each equipment console/rack/enclosure.
    ii. Power cords from individual equipment to power outlet strips to be shortened to proper length and neatly dressed into the rack or console. Use cradle clamps with removable rubber retainers to secure power cords to the side of the rack supports. Do not secure power cords using non-reusable supports.
14. Labeling:
    i. Equipment Markings: Present only needed information and be readable from the operator's or service personnel's normal work position. Markings to be designed to avoid ambiguous interpretation.

ii. Networked devices must have an LCD screen that works directly with the network in real time displaying the correct node number.

iii. A descriptive title shall be assigned to each piece of equipment.

1. Apply an engraved designation title plate to both the front and rear panels of rack-mounted equipment, and to the outside case or enclosure of equipment mounted within a rack.
2. These same titles will also be indicated on block diagrams, wiring drawings, and installation drawings.
3. Use plain English (example: Power Amplifier No. 2-1).

iv. Signal and Control Cabling: Individually identified. A unique number located approximately 1.5 inches (38 mm) from cable termination connector at both ends of a cable.

1. Cable Identification Number: Impressed on a fixed length of white shrinkable tubing with a heat impression stamping machine.
2. Lettering: Filled with a black filler and covered with a protective coating after shrinking that will not crack, peel or yellow.
3. After installation, cover labels with clear heat shrinkable tubing.
4. Letters to be 0.25 inches (6 mm) in height.
5. These unique numbers to appear on "as built" documentation to be supplied at the completion of the project.
6. f. Markers pre-shrunk to approximate size before installing.
7. Orient for cable markers for ease in viewing before installation.

3.04 FIELD QUALITY CONTROL

A. Field Inspection: Coordinate field inspection in accordance with appropriate sections in Division 01.

B. Manufacturer's Services: Coordinate manufacturer's services in accordance with appropriate sections in Division 01.

C. Overall system Performance Requirements and Qualifications:

a. Validate System as Specified. Fully document Work performed with a neat copy presented for acceptance by sound masking consultant and included in the system manual. Costs for tests to be borne by the Installer.

b. Tests Required: To greatest extent possible, pre-assemble and test system component sub-assemblies, including consoles, rack assemblies, interconnections, and system assemblies (excluding, of course, input and output transducers) in Design Builder's own facility.

i. By Installer at Installer's Facility:

c. Frequency Response: Overall frequency response of the complete electronic system (un-equalized) to be 65 to 15,000 Hz plus or minus 2 dB. Equalizing circuits shall be temporarily set in the indicated "flat" position. Other equalization devices shall be temporarily removed and replaced with equivalent loss networks.

d. Distortion: Total harmonic distortion at full power; less than 1.5 percent for frequencies of 50, 1000, 10,000 and 15,000 Hz.

    i. Equalization and Other Testing by Installer at Job Site:

        1. After the following has been installed at the job site, equalize and acoustically test.

    ii. Electronic equipment specified.

    iii. Ceiling speakers.

    iv. Ceiling system with relevant return air sound boots in place.

e. Tests to be performed with HVAC system and ultrasonic motion detectors, turned off. Carpeting, workstations, desks, chairs, acoustical wall panels, and other materials that may influence acoustical characteristics of the space to be installed prior to testing.

f. Equalize complete system in all zones to meet octave and third-octave sound spectrum requirements per Design Criteria.

g. After zones are equalized, set sound level, measured in dBA for each zone to meet Design Criteria. If variation in sound level in a particular zone or area exceeds the nominal value in excess of 2 decibels, adjust individual loudspeakers as required.

h. Set time clock as follows for all zones (verify with Owner):

    i. Monday - Friday 7 am to 7 pm: 0 dB.

    ii. Monday - Friday 7 pm to 7 am: - 3 dB.

    iii. Saturday, Sunday: - 3 dB.

i. All these tests, and any others that the Installer may wish for his own satisfaction, to be performed and successfully achieved before observation is requested for the sound masking consultant. The Consultant may request repetition and demonstration during observation of tests or other critical tests if problems become apparent. If specifications are met, acceptance of the system after this observation may be expected.

j. If specifications are not met, further observations by the Consultant will be at the Installer's expense.

3.05 ACCEPTANCE DOCUMENTATION

A. Acceptance: Official acceptance of the system covered by this specification will occur when the Installer receives the following written documents:

    a. A letter from the Sound Masking Consultant to the Architect acknowledging Final Acceptance of the system stating compliance with all articles of the specifications.

b. A letter from the Architect to the Installer stating that all related Work has been completed to his satisfaction. Until these documents are received, the installation is not formally complete. The official date of acceptance shall be the date of the letter.

c. Installer will supply complete system documentation with installed system.

   i. Furnish a complete instruction manual as provided by the manufacturer containing an operation description, schematic diagrams, parts layout drawings, as-built drawings, and parts list with each component time supplied by the Installer.

   ii. A list of all instruments, including accessories by manufacturer and type number used by the Installer to obtain test data to be submitted to the Owner with maintenance recommendations for equipment furnished under this contract.

   iii. System geographical layout and block diagram under a plastic cover on the inside of the equipment enclosure front door.

   iv. Record of final field tests and measurements include final adjustment of system.

d. Installer will supply complete manufacturers instruction manuals (operation and service) for each purchased system component.

   i. Instruction manuals to contain an operational description of components, schematic diagrams, parts layout, parts list, and maintenance instructions, preventive and corrective.

   ii. Organize manuals by system and present in bound volumes, one volume for each system. Provide three copies of each volume.

3.06 DEMONSTRATION AND TRAINING

A. After required approvals have been issued, and at a time designated by the Owner, the Installer will demonstrate to the Owner’s maintenance personnel the operation and maintenance of items installed under the Work in this section.

B. Instruction:

   a. After the system is totally installed and in proper operating condition as directed, the Installer shall provide instruction sessions as necessary to describe and demonstrate the entire system to the Owner’s engineering staff, and those others who will be in charge of or otherwise related to the system operation.

   b. The session shall be scheduled by the Owner and shall be held at a time convenient to the Owner and shall be at least 4 man-hours.

   c. The operation manuals described above shall be completed at the time of the instruction session and at this time supplied to the Owner to aid in the system description.

3.07 CLEANING AND PROTECTION

A. Clean products in accordance with the manufacturer's recommendations.

   a. Debris resulting from system's installation must be continuously removed during and after installation.

b. Equipment shall be thoroughly dusted and cleaned after installation.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.08 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

27.51.23 - CENTRAL PUBLIC ADDRESS/PROGRAM DISTRIBUTION SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.01 SCOPE

A. Furnish and install a complete telephone-accessed zone paging/program music distribution system with all wire, outlets, jacks and equipment as may be required, as shown on the drawings, and as herein specified. Any material and/or equipment necessary for the proper installation and operation of the system, which is not specified or described herein, shall be deemed part of this specification.

B. Included in the Scope of this Section:

   a. Licenses, permits as may be applicable

   b. Provision of submittal information

   c. Installation in accordance with contract documents, manufacturers' recommendations, and applicable codes

   d. Programming and configuration of control and signal processing software

   e. Testing and adjustments, including documentation thereof

   f. Provision of manuals

   g. Maintenance and warranty services

C. Applicable References:

   a. National Electric Code (NEC)

   b. Underwriters Laboratories (UL)

   c. Sound System Engineering (Davis & Patronis) – 3rd Edition 2006

   d. Audio Systems Design and Installation (Giddings) 1990

   e. Telecommunications Distribution Methods Manual (TDMM)

D. In general, the conduit, electrical outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed under the Electrical Contract. The entire responsibility for the system, its operation and function shall be that of the Contractor.

1.02 DESCRIPTION OF THE WORK

A. The system shall consist of a modular microprocessor control unit, telephone interface module, zone modules, amplifier, digital feedback terminator, power supplies and all associated material, hardware, wiring, and options as described herein to provide a complete working system which shall meet the functional requirements as described herein.

1.03 SYSTEM FUNCTIONS

A. System shall provide centralized, telephone-accessed, zoned paging, allowing for public address announcements. In addition, the system shall accept input from a wired microphone to initiate all-call pages.

B. System shall provide a back feed signal to the existing hospital paging system for extension of pages throughout both new and existing areas of the hospital.

C. System Operation: Headend equipment shall be located as shown on plans and shall consist of a programmable, modular, zoned paging interface designed for operation with the existing Cisco IP based telephone system. Also included shall be power amplifiers. The system shall provide the following functions:

   a. Transmit paging announcements originating from the owner-provided telephone system or from a contractor provided new wired microphone to any one or all speaker zones simultaneously

   b. Transmit microphone announcements to all speaker zones simultaneously

   c. Transmit user programmable tones for various emergency alert situations including Tornado, Evacuation, etc.

D. Provide a minimum of six (6) hardwired speaker zones as follows (TBD by owner).

E. Functional prioritization of signals shall be as follows in descending order:

   a. Emergency Alert Tones

   b. Microphone-originated Public Address Announcements

   c. Telephone-originated Public Address Announcements

1.04 QUALITY ASSURANCE

A. The intent of these Specifications is to describe and provide for a complete Public Address System of professional quality and reliability. Professional performance standards as provided by a qualified and experienced sound systems contractor (hereafter referred to as Systems Contractor) will be required. References and documentation of the System Contractor’s experience and following qualifications shall be provided, if requested.

B. The Systems Contractor shall:

   a. Be an authorized dealer/service organization for all major items of electronic equipment furnished.

   b. Be located with 100 miles of the project.

   c. Have completed, within the past two (2) years the satisfactory installation of at least three (3) systems of similar size and type as that herein specified.

   d. Maintain a factory trained service department on call 24 hours a day, 365 days a year, to service the specified product.

e. Employ, on a full-time basis, a qualified audio/electronics Engineer under whose direction and supervision the entire installation shall be carried out. Infocomm, NICET or C-EST audio certification required.

f. Employ, on a full-time basis, technician(s) who are experienced in the installation of sound reinforcement equipment, its interconnection and setup. Qualified technicians shall perform the assembly, wiring, interconnection setup and programming of all equipment, jacks and devices. Infocomm, NICET or C-EST audio certification required.

C. The Systems Contractor shall coordinate final utility rough-in locations with actual equipment furnished. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations, and all applicable code requirements.

D. In all cases, the Owner and Engineer shall determine the acceptability of the work based upon site visits and observations.

1.05 COOPERATION AND COORDINATION

A. Cooperate and coordinate as required with the other contractors who are responsible for work not included in this section.

B. Provide any and all information as required or requested by the Owner, Engineer, or Construction Manager in order for this work to be completed to the satisfaction of the Owner, and in the best interests of the Project. Such assistance or information shall be transmitted in writing to the requesting party in all cases.

1.6 WARRANTY

A. Warrant all workmanship, equipment, material, and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. Where manufacturers’ warranties on certain equipment exceed three (3) years, the guarantee period on that particular equipment shall match the extended warranty period.

1.7 SHOP DRAWINGS AND SUBMITTALS

A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30” x 42”, 24” x 36” paper. Equipment lists, data sheets, etc. Shall be 8-1/2 inches x 11 inches size properly bound into a single or multiple volumes.

B. Submit the following for approval:

a. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.

b. Manufacturer's data sheets on all equipment items.

c. System block diagram(s)

d. Floor plan showing zone assignments.

e. Proposed construction details for all custom fabricated items, including interface panels, patch panels, and wall plates. These details shall show dimensions, materials, finishes and color selection.

f. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

C. Refer to Shop Drawing requirements in Specification General Requirements.

1.8 FINAL DOCUMENTATION

A. All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner the following:

B. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers, and quantities of each item.

C. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts, and other designations and coding’s.

D. Operations instructions for each major item of equipment furnished.

E. Manufacturer's warranty for each major item of equipment furnished.

F. Refer to Record Drawing and Operating and Maintenance requirements in General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment items shall be new and unused.

B. The following sections specifically list the acceptable equipment types and items for this project. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

2.02 SUBSTITUTIONS

A. Products specified herein by manufacturer's name and model numbers are intended to establish a minimal level of quality, performance, and function. Proposed substitute equipment by listed equal manufacturers shall be equal in all respects to the specified product.

2.3 EQUIPMENT

A. Control electronics shall be designed for direct connection to loop start and ground start trunks, to PBX or KEY paging ports that supply DTMF capability and to analog T/R lines. They shall consist of the appropriate modules as specified and shall be registered under Part 68 of FCC rules. All modules shall be designed for wall-mounted installation and shall be panel-mounted in the interior of a locking equipment cabinet. The control electronics shall be a Bogen PCM-2000 System or equal by Valcom or Viking. Provide the following modules as required to provide a minimum of eight (8) paging zones:

   a. Central Processing Module shall be a Bogen PCM-CPU. Provide one (1).

   b. Telephone Interface Module shall be a Bogen PCM-TIM. Provide one (1).

   c. Four-zone Paging Module shall be Bogen PCM-ZPM. Qty. as required.

   d. Power Supply shall be a Bogen PCMPS2. Provide one (1).

B. Mixer with Tone Generator: Provide a mixer with eight (8) module bays capable of accepting plug-in modules, with two (2) bays also capable of accepting signal-processing plug-in output modules. Each channel shall have four (4) selectable levels of priority addition to its own independent volume control, and LED signal/clip indicator. The mixer shall have a master volume control, bass and treble controls, an 11-segment LED output level meter with switchable Peak Hold meter to monitor output level of the mixer. The mixer shall have an unbalanced output jack, a 125 Hz Lo-cut feature, tone control bypass switch and balanced transformer-isolated output with output signal level switch (-50, -10, and +4 dBμ). The mixer shall be capable of bridging to another mixer. The mixer shall have a motorized volume control capable of remote operation and be rack mountable. Optional security covers shall be available to protect tone controls prevent tampering with module controls. The maximum balanced output level shall be: +18 dBu. Frequency Response shall be 20 Hz to 20 kHz (+/- 1 dB) with less than 0.01 percent THD+N @ +18 dBu and a fundamental signal-to-noise ratio of -99 dB. The mixer shall have a three-year warranty. Provide one (1) Bogen model VMIX mixer with Quam model AS17x16 wall-mount where shown in schematic drawings. Provide

   with the following modules as shown in drawings:

   a. Microphone Input Module shall accept low impedance mic level balanced signal levels from 28 – 62dBu, provide switchable phantom power, two-band tone adjustments (centered at 100Hx and 1kHz), limiting with adjustable threshold and gating with adjustable duration and threshold and four (4) selectable levels of priority muting. Provide one (1) Bogen model MIC1S microphone input module or equal.

b. Tone Generator Input Module shall provide four (4) selectable tones out of a total of eight (8) possible choices. The module shall be assignable to one (1) of four (4) assignable priority levels. The choices shall be: 512Hz burst/steady, slow whoop, siren, mechanical bell, Klaxon, night ringer, double chime and doorbell. Provide one (1) Bogen model TNG1S tone generator input module. The tone generator shall be interfaced with both the Emergency Tone Control Panel and the Clock System program schedule.

c. Input/Output Transformer-Balanced Module: The module shall be an input/output transformer isolated balanced module with integral relay. The line level input shall have a selectable input impedance of 600 ohms or 10k ohms. It shall include a level control with a gain range from -11 dB to +19 dB. The input shall be selectively mutable by higher priority modules. The output shall be selectively activated when a user-selected priority level is met or to be continuously on. The output shall include a level control with a gain control range from OFF to 0 dBu. The page port output connection shall be made via an RJ11 connector and shall contain both a dedicated N.O. contact and output signal. The relay contact shall be capable of selectively responding to any of three priority levels The relay contact (N.O. or N.C.) shall have a rating of 0.6A @ 120V AC or 2A @ 30V DC. The module shall provide external access to each of the priority buses through the mute control. Provide one (1) Bogen model RIO-1S Input/Output Module or equal.

d. Equal modular mixer system by Intelix or Peavey. Equal wall-mount shelf by Atlas Sound or Lowell.

C. Power Amplifier: The power amplifier shall be wall-mounted and capable of continuous operation at a rated 250 watts RMS. It shall provide a frequency response of 70Hz to 15kHz (+/-1dB) and deliver rated power at less than 1 percent THD. The signal-activated paging channel shall automatically mute music programs during a telephone-initiated page and have a VOX sensitivity adjustment to eliminate transmission of background noise. An automatic output leveling (ALC) circuit shall compensate for varying voice levels. An adjustable Aphex aural exciter circuit shall provide enhanced speech intelligibility. Input terminals shall be furnished for a telephone line and balanced microphone. An RCA jack or screw terminals shall be provided to input a music source. Terminals shall also be provided to control music mute during a microphone page. Balance or unbalance outputs shall be provided for 16-ohm, 25V, 25VCT and 70V speaker lines. Individual controls shall be provided to set the telephone and mic page volume, music volume, night ringer volume, VOX sensitivity and music mute level. The amplifier shall be equipped with a resettable circuit breaker and thermal and electronic overload protection. The unit shall be suitable for mounting directly to a wall or telephone backboard. Provide two (2) Bogen model TPU250B wall-mounted amplifiers or equal by Valcom or Viking.

D. Miscellaneous Control Electronics

a. Digital Feedback Terminator – The digital feedback terminator shall record and playback audio pages upon replacement of the telephone handset in the cradle. It shall provide 120-seconds of total audio memory and be capable of recording a message while another is being played, stacking up to eight (8) messages for playback. It shall regenerate zone controlling DTMF signals while stripping them from the playback message. Operation shall be either automatic or externally controlled. Messages shall be able to be aborted before playback by special DTMF signals. Provide one (1) Bogen model DFT-120 digital feedback terminator or equal by Valcom or Viking.

b. Telephone Access Module – The telephone access module shall be capable of providing either trunk port access to the digital feedback terminator when station port access is provided by the telephone switch. It shall automatically terminate paging access upon hang up. It is not required when the paging signal from the telephone switch is provided from a trunk port or paging port. Provide one (1) Bogen model TAMB telephone access module or equal by Valcom or Viking where necessary.

c. Emergency Tone Control Panel: Shall be located in the Main Reception desk. It shall provide four (4) pushbutton switches to access the following functions: Tornado, Evacuate, All-Clear and Off. The individually programmable buttons shall have selectable momentary, latching or interlocking action with LED status indicators. The two-gang plate shall be permanently labeled. Provide with power supply and manufacturer recommended cable with the need quantity of conductors to provide the specified functionality.

E. Speakers

a. Corridor Ceiling Speaker Assemblies

i. Provide an 8-inch speaker with a 5 oz. magnet complete with 25-volt multi-tap line matching transformer. Program rating shall be 15 watts continuous.

ii. Provide a white round recessed steel baffle with each unit and matching backbox and tile support. Speakers in drop ceilings can be 2x2 ceiling grid drop-in assemblies.

b. Surface-mounted Speakers: The surface-mounted speakers shall be comprised of an 8- inch speaker with a 5 oz. magnet complete with 25/70-volt multi-tap line matching transformer with taps of 5/16, 5/8, 1-1/4, 2-1/2, 5 watts and a program rating of 15 watts continuous. The speaker shall be mounted in a .030 zinc-treated steel enclosure finished in white baked powder epoxy with matching steel baffle. Provide Quam model System 3 or equal by Atlas Sound, Bogen, Dukane, EVI or Lowell.

c. Horn speakers; Atlas Sound Model AP30T reentrant type horn with 30-watt drive with screwdriver-selectable, 25/70-volt multi-tap transformer.

F. Microphone jacks; 5-pin XLR-F type mounting to single gang wall boxes, and finished with single gang satin finish wall plate.

G. Wiring

a. All wire and cables shall be new and unused.

b. Wire not installed in equipment racks, not portable, or not installed in conduit shall be plenum rated and meet all applicable codes.

c. Hallway and Common Area Speaker cable: West Penn 25224 stranded 18AWG twisted pair, or equal, from the central equipment cabinet, parallel-wired to the loudspeaker transformers.

d. Speaker Cable: West Penn 25357 stranded 22 AWG twisted pair with foil shield plus 22 AWG twisted pair or equal. The shielded pair shall be terminated at the individual speaker transformer, while the unshielded pair remains unterminated for future utilization.

e. Microphone-level and line-level audio cable (installed, not portable): West Penn 25357 stranded 22 AWG twisted pair with foil shield plus 22 AWG twisted pair or equal.

f. Portable microphone cables: ProCo M-Series black flexible cable or equal by Whirlwind, Conquest or Rapco.

g. Acceptable cable manufacturers: Belden, Carol, General or West Penn

h. Other equipment control cables shall be stranded wire, appropriately shielded, of gauge and number of conductors in accordance with the recommendations of the systems manufacturer and in compliance with the National Electric Code and local regulations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed and wired in accordance with manufacturer's requirements and accepted engineering and installation practices. Only the highest degree of workmanship will be accepted.

B. Contractor shall identify and tag all cables with permanent type markers to denote location served.

C. All splices shall be made in approved manner and shall be located only in junction boxes or other accessible points. No splices are permitted in conduits or raceways. When splicing shielded cables, continuity and isolation of the shield shall be maintained throughout the circuit.

D. All cables shall be installed in conduit except above accessible ceilings, where they shall be installed utilizing J-hooks or bridle rings on minimum 4 ft. centers or cable tray, where available.

Provide an electrical wall box with conduit stubbed above accessible ceilings for all wall-mounted peripheral devices.

E. Speakers may need to be re-tapped to accommodate special conditions such as high noise areas or non-standard ceiling heights. This shall be done, as necessary, at no additional cost. Under no

condition shall the average audio levels be less than 20dB above the average ambient noise level of an occupied space as measured at 2KHz. In the absence of such special conditions, speakers shall be tapped as follows:

a. Eight-inch/25-volt restroom and office speakers – ½ watt
b. Eight-inch/25-volt corridor or public area speakers – 1 watt
c. Mechanical/Shell Paging horns - 4 watts

3.02 AS-BUILT DOCUMENTATION

A. The Contractor shall furnish to the Owner two (2) complete as-built manuals. These manuals shall be assembled in loose-leaf binder and shall contain:
   a. System Operating Instructions
   b. System Functional Block Diagram(s)
   c. System Schematic Diagram(s)
   d. System Operating Manual(s)
   e. System Wiring Schedule(s)

3.03 FINAL CHECKOUT AND ACCEPTANCE

A. The Contractor shall verify that the system is complete and fully operational before requesting final approval and before scheduling system demonstration.
B. This Contractor shall be available to demonstrate the operation and use of the system to the Architect/Engineer and to the Owner’s representatives.
C. At the time of the demonstration, this Contractor shall furnish to the Owner two (2) complete record manuals.
D. Final acceptance of the system will be given upon completion of all of the above requirements.

3.8 PROGRAMMING

A. Coordinate programming of the system with Owner. Programming shall include, but not be limited to paging zones and zone groups, priority levels and selectable tones.

3.9 OWNER TRAINING AND FAMILIARIZATION

A. Training of owner's personnel shall be done by the Contractor. The Owner and/or his designated representative shall be fully advised as to the function of all operating controls and in techniques necessary to ensure proper operation of the entire system. The training session may include more than one trainee. If possible, several people should be trained. It may be necessary to return for another session, possibly during an actual use of the system. Provide a minimum of eight (8) hours

of instruction and familiarization for this purpose. Video record all training and provide two (2) copies to Owner. The Engineer or his representative will participate during the training period.

3.10 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

28

DIVISION

28.05.00 - BASIC ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL

A. All provisions of the Division 00 and Division 01 apply to work specified in this Division.

B. The Electronic Safety and Security drawings and specifications assign work (labor and/or materials) to be provided by the General, Electrical, Communications, Plumbing, Fire

Suppression or HVAC Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.02 SCOPE OF WORK – ELECTRONIC SAFETY AND SECURITY (ESS)

A. The scope of the Electronic Safety and Security work includes furnishing, installing, testing and warranty of all Electronic Safety and Security work and complete Electronic Safety and Security systems shown on the Electronic Safety and Security drawings and specified herein.

1.03 ALTERNATES

A. Refer to the description of Alternates in Division 01 which affect the Electronic Safety and Security work.

1.04 PERMITS AND REGULATIONS

A. Include payment of all permit and inspection fees applicable to the work in this Division. Furnish for the Owner a certificate of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state, and federal laws, ordinances, and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the local jurisdictional authority.

D. All electrical work shall be inspected and approved by the Ohio Division of Industrial Compliance who will issue the inspection certificate.

E. Upon completion of work, the Electronic Safety and Security Contractor shall furnish to the consulting State Architect, the certificate of inspection and approval before final payment on contract will be allowed.

F. Final acceptance of all work will also be subject to the approval of the Owner.

1.05 DRAWINGS AND SPECIFICATIONS

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.

D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork, piping and electronic safety and security wiring shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces About Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance and Access to Work Space – 110.34 Work Space and Guarding. The Electronic Safety and Security Contractor shall caution other trades to comply with this stipulation.

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of conduit, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches, and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.06 INSPECTION

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Final inspection certificates shall be obtained by the Contractor and given to the Owner.

1.07 RECORD DRAWINGS

A. The Electronic Safety and Security Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.08 OPERATING AND MAINTENANCE MANUALS

A. Two copies each of operating and maintenance manuals shall be assembled for the Electronic Safety and Security work by the Contractor.

B. All shop drawings and installation, maintenance, and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

E. O & M manuals shall contain the following information at a minimum:

a. Copies of all approved shop drawings with the Engineer’s stamp.

b. 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 digital storage with electronic versions of Owner's manuals. digital storage containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

c. Electronic Safety and Security drawings updated with final as-built information. This shall be in the form of a complete set of Electronic Safety and Security drawings with as-built information indicated in colored pen based upon actual field conditions.

d. 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.

e. Rack elevations for all systems with rack mounted equipment.

1.09 FINAL INSPECTION AND PUNCH LIST

A. As the time of work completion approaches, the Contractor shall survey and inspect his work and develop his own punch list to confirm that it is complete and finished. He shall then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Owner for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion, or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.10 WARRANTY

A. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of three (3) year or the period of time as per specific specification section from the date of approval of certificate of contract completion by the Owner. Refer to General Conditions. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.02 REFERENCE STANDARDS

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.03 EQUIPMENT SELECTION

A. The selection of materials and equipment to be furnished under this contract shall be governed by the following:

a. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

b. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

c. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing

of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.

D. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes by all other trades shall be deemed to be included in the contract.

2.04 SHOP DRAWINGS

A. Six sets of shop drawings and descriptive information shall be assembled by each Contractor of equipment and materials furnished in his contract and submitted to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before installation and before special equipment are manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Shop drawings for equipment, fixtures, devices, and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Electronic Safety and Security Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

PART 3 - EXECUTION

3.01 TESTING

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. The Contractor shall perform meager and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

D. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Refer to specific section for required tests of the various systems. Submit four (4) copies of reports indicating results.

E. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration, and results of tests. Copies of all test reports shall be included in the O&M manuals.

F. Instruments required for tests shall be furnished by the Contractor.

3.02 EQUIPMENT CLEANING

A. Before placing each system in operation, the equipment shall be thoroughly cleaned;

cleaning shall be performed in accordance with equipment manufacturer's recommendations.

B. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.03 OPERATION AND ADJUSTMENT OF EQUIPMENT

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents; verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

3.04 OPERATING DEMONSTRATION AND INSTRUCTIONS

A. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.

B. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O & M Manuals shall be submitted, reviewed, and approved prior to scheduling of demonstrations.

D. A minimum of 24 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:

   a. Show location of items of equipment and their purpose.

   b. Review binder containing instructions and equipment and systems data.

   c. Coordinate written and verbal instructions so that each is understood by personnel.

   d. Manufacturer’s representatives for the various special and communication systems shall give separate instructions.

E. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

F. Note that additional time for training, operating time, etc. may be required per other specification sections and shall be included. This section only establishes minimum requirements.

3.05 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

28.05.28 - ELECTRONIC SAFETY AND SECURITY SYSTEMS PATHWAYS AND SUPPORT EQUIPMENT

PART 1 - GENERAL – Not Applicable

PART 2 - PRODUCTS

2.01 CABLE MANAGEMENT SYSTEM

A. Provide pre-manufactured cable supports as manufactured by Panduit, Caddy, Mineralac or Rayco. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48”.

B. Cable management devices must be sized to accommodate 100% spare capacity of the final installed cable base.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bend, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

D. Bridle rings shall not be acceptable.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Refer to drawings for pathway types, locations and routing.

B. Cable pathways shall provide the following minimum clearances:

   a. Motors and transformers – 4 ft.

   b. Conduit and cable used for electrical power distribution – 1 ft.

   c. Fluorescent lighting – 5 inches.

   d. Power lines up to 5 kV – 5 inches.

   e. Power lines over 5 kV. – 24 inches.

C. Backboards and cabinets shall be installed in Electronic Safety and Security rooms/spaces to support Electronic Safety and Security equipment and wiring. Coordinate locations of backboards and cabinets with the Owner prior to installation.

D. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors, and ceilings by sealing with approved means.

E. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from area above suspended ceilings to respective backboards.

F. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation, or cooling.

3.02 CONDUIT SYSTEMS

A. No section of conduit shall be longer than 100 feet between pulling points.

B. No more than two 90 deg. bends in a section of conduit between pulling points.

C. Each section of conduit shall be labeled for length, destination closet and origination closet.

D. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

E. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.

F. Provide a No. 12 gauge pull wire or nylon pull cord in each empty conduit run.

3.03 WIREWAYS

A. Wireways shall be supported with factory made hangers designed expressly for this purpose and 0.375” diameter solid hanger rods approximately 5 ft. on center or approved strap hangers for surface mounting.

3.04 CABLE MANAGEMENT SYSTEM

A. The drawings do not indicate specific routes for cables. The Electronic Safety and Security Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Electronic Safety and Security Contractor shall be responsible for developing alternative pathways and shall include all

labor and material for doing so within the scope of this work.

B. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 feet of horizontal run. Cable pathways shall provide the following minimum clearances:

a. Motors and transformers – 4’.

b. Conduit and cable use for electrical power distribution – 1’.

c. Fluorescent lighting – 5”.

d. Power lines up to 2kVA – 5”.

e. Power lines over 5kVA – 24” cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.05 IDENTIFICATION / LABELING

A. All continuous Electronic Safety and Security pathways such as conduit, cable tray, etc. shall be labeled to indicate origination and destination. Label shall be applied every 50’ wherever accessible or subject to administration. Coordinate label information with Owner.

B. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned / prepped area of raceway.

3.06 AS-BUILT DOCUMENTATION

A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate “as-built” locations to show the actual route for the communications systems pathways.

B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.

C. Component Service Manuals: Include information for testing, repair, troubleshooting, assembly, disassembly, and required / recommended maintenance intervals for all types of pathways.

3.07 FIRESTOPPING

D. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors, and ceilings by sealing with approved means.

Note: When using cable tray and tray rated cables in industrial establishments, coordinate any specific fire ratings / protection with Owner and Plumbing Designer – Factory Mutual, Industrial Risk Insurers (IRI) and ISO may require added fire rating requirements such as special cable insulation or foaming open cables in cable trays. Also, be aware of spaces above ceilings being used for air plenums.

END OF SECTION

28.13.00 - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes an IP browser-based security access control system (ACS) consisting of a ACS Module, supporting networked module(s), operating system and application software, and field-installed Readers connected by a high-speed electronic data transmission network. This system's features include regulating access through controlled openings, credential management, monitoring of field devices, and reporting hardware.

1.02 REFERENCES

A. Abbreviations and Acronyms

1. ACS Access Control System
2. AES Advanced Encryption Standard
3. I/O Input/Output
4. LAN Local Area Network.
5. LED Light-Emitting Diode
6. PC Personal Computer
7. RFID Radio Frequency Identification
8. TCP/IP Transport Control Protocol/Internet Protocol
9. UPS Uninterruptible Power Supply.
10. WAN Wide Area Network

B. Definitions

1. ACS Host Workstation – Any network connected device with software that supports a commonly used browser (Chrome, Firefox, IE, others
2. Reader – Any OSDP device that is capable of identifying a credential (keypad code, RFID, or biometric. Alternately, the reader may be Wiegand based, but that technology will require conversion to OSDP. with
3. Credential - RFID based token, personal code, or biometric feature assigned to an entity or used to identify that entity.
4. Identifier - A credential card, keypad personal identification number or code, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

5. Modbus TCP/IP - Industrial automation networking communication protocol for communications between devices connected to the same network.
6. RS485 – Communication protocol used between components of the ACS.
7. OSDP – Open Supervised Device Protocol is an encrypted communication between the reader and the PCB.
8. PC (Personal Computer) An ACS Workstation or any supporting workstations,.
9. RFID - An automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.
10. RS-232 - A TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines certain signal characteristics for interfacing computer equipment.
11. Workstation - A PC, tablet, or smartphone with software that is configured for browser connection.

C. Reference Standards

1. SIA BIO-01-1993.02(R2000.06) - Biometric Standard - Vocabulary for Testing
2. Institute of Electronic and Electrical Engineers (IEEE) 802.3 standards
3. Underwriters Laboratories
   a. UL 294 - Access Control System Units
   b. UL 294B - Power Over Ethernet
4. FCC 47, CFR Part 15
5. Industry Canada - Radio Standards Specification RSS-210 License-exempt Radio Apparatus
6. National Institute of Standards and Technology (NIST)

a. FIPS 197 - Advanced Encryption Standard (AES)

7. ISO 14443A, 14443B - Proximity Cards
8. EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces
9. ETSI EN300, EN330-2, EN301 489-1

1.03 ACTION SUBMITTALS

A. Product Data

1. Manufacturers' printed and electronic data sheets, including operating characteristics, furnished specialties, and accessories.
2. References for each product to a location on Drawings.
3. Test and evaluation data presented in compliance with SIA BIO-01
4. Manufacturers' installation and operation manuals

B. Shop Drawings

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Part 2.
3. Wiring Diagrams. Show typical wiring schematics including the following:
    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.
    d. Active network components.

C. System installation planning documents

1.04 CLOSEOUT SUBMITTALS

A. Field quality-control test reports

B. End User Training Plan

C. Operation and Maintenance Data

1. Microsoft Windows software documentation.
2. For each PC, bookmarking of connection in the browser and operating documentation, manuals for all installed peripherals.
    a. Include system backup/restore.
    b. The software shall have detailed on-screen help links to describe the functions of all fields and shall include all other information necessary to enable proper programming and operation. The manual shall fully explain all procedures and instructions for the operation of the system.
3. System installation and setup guides.

D. List of recommended spare parts

1.05 QUALIFICATIONS

A. Manufacturer shall have a minimum of ten years of experience in manufacturing access control equipment.

B. Installers shall have been trained, certified, and approved by the Manufacturer.

1.06 WARRANTY

A. Manufacturer shall provide a limited three-year hardware warranty for the product to be free of defects in material and workmanship.

B. Manufacturer shall provide software updates for a minimum of 365 days after commissioning.

C. Manufacturer shall make available an extended warranty and maintenance support option.

PART 2 - PRODUCTS

2.01 DESCRIPTION

A. The system shall consist of browser software, and optionally, one or more client workstations, Host module, door modules, elevator modules, OSDP based Reader and input/output modules connected by a RS485 LAN data transmission network. Systems utilizing door controllers that have been modified with an Ethernet connection are not acceptable.

B. The network connecting the ACS Host Module, Client Workstation(s), and any additional door. Elevator, or input/output modules shall be a Local Area Network (LAN) utilizing RS485 or RS485 over TCP/IP communications protocol and having the capacity of connecting the required number of devices and workstations.

C. Functions - The systems primary functions shall include:

1. Regulating access through doors, gates, turnstiles, elevator floors, and other entrance portals
2. Regulating access to medical cabinets, data cabinets, vehicles and other devices that is beneficial to control access and provide an electronic audit.
3. Tracking Zones and Mustering/Anti-Passback
4. Credential cards and readers
5. Credential creation and credential holder database and management
6. Unified Intrusion system embedded on the same hardware/software.
7. Monitoring of field-installed devices
8. Reporting

D. Third Party Devices - In addition to supporting the Manufacturer’s own proximity readers, the system shall support the following types of readers:

1. Any device with a Wiegand based output including, but not limited to, the following:
    a. Biometric readers from multiple manufacturers
    b. Long range vehicle readers commonly used in parking garages, gated areas, etc.
    c. Combination proximity reader and electric locking devices
    d. Any Wiegand device will require a Wiegand-OSDP converter

2.02 SYSTEM SOFTWARE

A. The access control application software shall provide the interface between the ACS Host Module, door modules, Input/output modules, and elevator modules in order to monitor sensors, report alarms, generate reports and provide all other system functions.

B. The system shall provide software modules for system administration, credentialing, ACS Host functions and creation of system reports.

C. The system software shall not be licensed by number of doors, card readers, card holder, client connections, etc.

D. System Functions - The access control system software functions shall include the following:

1. Door Programming
    a. Extended open alarms
    b. Individual Extended open timers per door
    c. Personal Identification Number (PIN) Codes – Up to 5 digits
    d. Device Support - Supports selected serial RS-232 and Wiegand devices.
    e. Number of Door Groups - Unlimited
2. Shifts
    a. Number of shifts - Unlimited
    b. Interval assignments - Any day of the week
3. Permissions - Unlimited number
4. Holidays - Unlimited number
5. Door Control
    a. Door control based on dual-authentication rules.
        1) Support requiring credentials belonging to two people
        2) Support requiring two credentials belong to same person
    b. Cardholder use limits
        1) Elapsed Time based
        2) Number of usages based
    c. Configurable individual door strike times.
    d. Configurable extended individual door holds open times.
6. Elevator Control - provide simplified elevator control for up to 96 floors.
7. Support Intrusion alarm events and communication to a central monitoring station
8. Alarm and Event Logging - provide for logging of all system alarms and events chronologically including time and date stamp. Specific alarm conditions monitored include:
    a. Door Unauthorized Open Alarm
    b. Door Extended Open Alarm

c. Reader-Controller Tamper Alarm
d. Data link interruption Alarm

9. System Scheduling - provide for scheduling of events including:
   a. Open-Door, Open-Door Group
   b. Deactivate Badges
10. Help Documentation – provide access to detailed on-screen help.
11. Alarm and Monitoring Attributes - provide for programming of the following:
   a. Display of alarm events at any ACS workstation
   b. Require the area or input which generated the alarm to be restored to its normal state before the alarm is cleared
   c. Require acknowledgment of an alarm to clear the alarm
   d. Support auto-clearing of network related communication alarms
   e. Trigger a programmed system actions(s) when the alarm is initiated or cleared.
   f. Restriction of alarm acknowledgment to authorized personnel only
12. Programming Downloads - provide for downloading of programming from the ACS Module to the associated modules as follows:
   a. Credential holders and authorized time zones
   b. Time zones.
   c. Latch intervals.
   d. REX, Tamper, Unauthorized.
13. Door Programming Options
   a. Request to exit and door position switch - Provide programming for flexible processing of the request to exit and door position switch
   b. Manual activation of outputs - Provide for configurable activation of outputs from a credential presentation
   c. User definable door strike time - Provide user definable/ programmable door strike functionality for each reader-controller
   d. In/ out Reader-controller configuration - Reader-controller programmed as either an in reader, an out reader, or a toggle reader for recording of time in and time out data
   e. Input/output linking - Provide programming for linking of reader outputs with inputs

E. ACS Software Functions - The system ACS software shall provide for the following features and functions:
   1. Multi-user multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations
   2. Device Status Monitoring

a. Alarm Status Indication - Provide real time status display that indicates the current status of all devices
b. Module status - Provide display of any modules that are offline.

3. Device Group Programming
   a. Door Groups - Provide for programming of Door groups
   b. Input Groups - Provide for programming of input groups
   c. Output Groups - Provide for programming of output groups
4. Historical Trace - provide for historical trace on any reader-controller or cardholder
5. Test Utilities - Provide system test utilities to allow for testing of the following functions via a mobile phone:
   a. Alarm inputs status.
   b. Output operations.
   c. REX/AUX
   d. Beeper
   e. Credential Presentations.
   f. LED and buzzer operations
   g. Content Verification of Reader-Control's internal database
   h. Battery status
   i. AC Input status

F. ACS Browser – The system shall provide a web-based client supporting all major browsers including Internet Explorer, Firefox, Google Chrome, and Safari.
   1. The web interface shall be one single license and provide unlimited concurrent users.
   2. The we- based interface shall be browser agnostic and be useable by any Apple or Android based device.
   3. Must provide an easy-to-use interface for day-to-day end user administration of the ACS.
   4. Must provide simplified step-based tasks for end user administrators.
   5. Shall provide at a minimum the following functionality
      a. Full installation of all access control hardware.
      b. Full configuration of all access control configuration.
      c. Full reporting functionality.
      d. Add People, Credentials and provide them Rules to access doors during a defined schedule through a single window
      e. Provide the ability to Admit access, Unlock, Lock or Lockdown a single door, group of doors or all doors in the system via the system dashboard
      f. Provide the ability to run History reports

g. Provide the ability to configure Badge Unlock and Auto Unlock rules for a single door or group of doors
h. Provide the ability to configure user logins and restrict the roles that login can perform within the web interface

G. Credential Management Software Functions - The system credential management software shall provide for the following features and functions:
1. Modification of cardholder records - Add, Modify and Delete records based upon user logon permissions.
2. Access and Credential Management
a. Provide for the following credential management functions:
1) Assignment of single or unlimited number of active badges to an individual.
2) Programming personnel groups
3) Programming of group access permissions
4) Programming the scheduled activation and deactivation of group access permissions
5) Programming of individual access permissions
b. Program Use Limits - Limiting the number of times that cardholders may use their credential to gain access

2.03 HARDWARE COMPONENTS

A. Control Devices
1. An ACS Workstation shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring.

B. Field Devices
1. Functionality
a. Field equipment shall include Browser based control module, Door Expander Modules, Elevator Modules, I/O Expander Modules.
b. Data exchange between the ACS Host Module and all other modules shall include down-line transmission of commands and firmware.
c. The up-line data exchange from all modules to the ACS Host Module shall include status data such as status reports, and entry-control records.
2. The Browser based controller requires the following connection interfaces:
a. USB
b. Ethernet Port
c. Tamper Input

d. 8 Universal Inputs
e. 4 Universal Outputs
f. RS485 LAN port
g. OSDP reader port
h. Backup battery connection
i. Onboard it needs to support a combination of the following.
    1) 4 Doors
    2) 8 proprietary readers
    3) 8 Wiegand readers with the use of OSDP-Wiegand converters
    4) 8 inputs
    5) 4 outputs
    6) 32 elevator cars
    7) 10,000 users
    8) 250,000 events

3. The 2-Door Expander module requires the following features:
    a. Offline 2000 user card cache
    b. Connections for 2 doors
        1) DOTL
        2) Door contact (reed input)
        3) REX
        4) REN
        5) Latch bolt connector (tongue switch)
    c. 4 Wiegand reader inputs
    d. OSDP reader input
    e. Heavy duty lock relays
    f. RS485 LAN connectivity
    g. Built-in module location buzzer
    h. External power supply monitoring capability
        1) AC fail
        2) Low battery
        3) LAN fuse

4) Detector fuse
5) Low volts
6) Power fail

4. The readers require the following features
   a. 128bit AES encryption
   b. Mifare DESfire© EV1/EV2 card format
   c. Water and dust resistance to IP67
   d. Vandal resistant
   e. Flexible LED color and function assignment
   f. Audible buzzer
   g. OSDP compatible
   h. Multi-Format version must be able to read CSN from 3rd party cards
   i. 39mm X 93mm X 15mm
5. The 8 Zone Input/Output Expander module requires the following features:
   a. 8 zone inputs
   b. 2 auxiliary outputs
   c. RS485 LAN connectivity
   d. Audible buzzer
   e. Internal and External variable tone siren outputs
   f. Bus in-cabinet expansion interface
6. The Elevator interface module requires the following features:
   a. Low level with button feedback Bus connectivity
   b. Ability to manage 16 floors per device
   c. Connect up to 6 devices to a host module
   d. Wide range of button input voltages
   e. Firmware upgrades over the wire

2.04 SYSTEM PERFORMANCE

A. The system shall use a single database for access-control and credential-creation functions.

B. The system must allow connection through a cloud-based service provided by the manufacturer to provide connection over the internet. All data is to be kept private and access to the site should b locked with SSL/TLS encrypted communication and authentication.

C. System Capacity

1. Door - 128
2. Readers - 256
3. Total access credentials – 10,000
4. Alarm inputs - 512
5. Alarm outputs - 512
6. Elevator floors – 96
7. Elevator cabs – 32
8. Events – 250,000

D. System Response to Alarms

1. Controllers shall provide a system end-to-end response time of 3 second or less for every device connected to the system.
2. Alarms shall be annunciated at the ACS Host Module within 3 second of the alarm occurring at a sensor or device monitored.
3. Alarm and status changes shall be displayed within 1 second after receipt of data by the ACS Host Module.

E. Network

1. The TCP/IP and RS485 network interconnecting the system components shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Network communication issues shall not require operator initiation or response, and the network shall return to normal after partial or total network interruption such as power loss or transient upset.
3. Data Line Supervision - The system shall monitor the status of the data transmission lines with the use of heartbeat messages. The loss of the heartbeat messages will cause an alarm condition within the ACS host.

F. Environmental - The system shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior Environment - System components, except computer workstation units, installed in air-conditioned temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 0 to 50 deg C dry bulb and 15 to 90 percent relative humidity, non-condensing. .
2. The case material shall be of ABS plastic and not more than 205mm X 94mm X 36mm. It should be powered with 12 VDC and backed-up with a battery.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. ACS Host Modules:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85-degrees F (10 and 30 degrees C), and not more than 80 percent relative humidity, non-condensing.
2. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.
3. Mark packing list with designations that have been assigned to materials and equipment.

B. Additional ACS Modules:

1. Store in temperature and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between -40 and 120-degrees F (-40 and 50 degrees C).
2. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.
3. Mark packing list with designations that have been assigned to materials and equipment.

3.02 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for Ethernet and RS485 LAN and control cable conduit systems to control module and all support modules readers, doors, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

3.03 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

C. Develop Project planning forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.

2. For each Location, record setup of IP based Reader-Controller features and access requirements.
3. Propose start and stop times for shifts and holidays and match up permissions for doors.
4. Set up groups, and list inputs and outputs for each IP based Reader-Controller.
5. Prepare and install alarm graphic maps.
6. Discuss badge layout options, design badges.
7. Complete system diagnostics and operation verification.
8. Prepare a specific plan for system testing, startup, and demonstration.
9. Develop acceptance test concept and, on approval, develop specifics of the test.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.04 INSTALLATION

A. Install all equipment in accordance with the manufacturer's installation manuals, wiring diagrams and recommendations.

B. Install, configure and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner

3.05 FIELD QUALITY CONTROL

A. Contractor shall engage a factory-authorized and trained service representative to inspect, test, and adjust components and equipment installation.
   1. Results shall be reported in writing.

B. Contractor shall perform the following field tests and inspections and prepare test reports:
   1. LAN Cable Procedures - Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
   2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

3. Operational Test - After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Contractor shall remove and replace malfunctioning devices and circuits and retest as specified above.

3.06 STARTUP SERVICE

A. Contractor shall engage a factory-authorized and trained service representative to supervise and assist with system startup service.

1. Representative shall complete installation and startup checks according to approved procedures that were developed in Section 3.03 and with manufacturer's written instructions.

B. Contractor shall engage a factory-authorized and trained service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system.

1. Representative shall develop separate training modules for the following:

a. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software

b. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel

c. Security personnel

d. Hardware maintenance personnel

e. Corporate management

3.07 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

28.13.33 - DOOR ENTRY VIDEO INTERCOM SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00, and Division 01 Specifications Sections, apply to this Section.

1.02 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.

1.03 SCOPE OF WORK

A. Provide an Intercom Video System which integrates with the intrusion detection system.

B. This scope includes all hardware, software, training, and services required to provide a fully operational system, programmed to the owner's requirements, and containing all software and licenses required to perform the specified functions.

1.04 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.

a. Power Source: Power over Ethernet (802.3af).

b. Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).

c. Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.

d. Bandwidth Usage:

i. G.711: 64Kbps x 2 per video call.

ii. 64Kbps per monitor.

iii. H.264: 24Kbps ~ 2,048Kbps.

B. Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).

C. Video Display: 3-1/2 inches (89 mm) color LCD.

D. Camera: Type:

   a. 1/4-inch (6 mm) color CMOS.

E. View Area: 2 feet 2 inches (660 mm) vertical x 3 feet 1 inch (940 mm) horizontal at 20 inches (508 mm).

F. Video Stream: ONVIF Profile S.

G. Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA - use EL-12S (use RY-1824L for larger contact rating, which requires 24V DC power supply) or use IWA-MA with 4 multipurpose relays.

H. Wire Type: CAT-5e or CAT-6.

I. Distance:

   a. Door Station or RA Station to Network Node: 330 feet (100 meters).

   b. Master Station to Network Node: 330 feet (100 meters).

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001:2000 certified company.

B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

   a. Finish areas designated by Architect.

   b. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.

   c. Refinish mock-up area as required to produce acceptable work.

C. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75-mile radius now rendering satisfactory service.

D. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

E. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.

F. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.06 CONTRACTOR QUALIFICATIONS

A. The Door Intercom shall be furnished, installed, and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the door intercom contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified door intercom. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

E. The contractor/subcontractor is required to answer all warranty and Service calls within 4 hours of the initial customer contact and provide an authorized technician onsite within 24 hours.

F. Proper identification is required and must be visible while onsite for warranty/service calls. Notification of completion must be provided to authorized personnel onsite before departing facility.

G. Consult and coordinate with all trades providing adjoining work and make an Adjustment or relocation necessary to accommodate other equipment or to maintain proper function of existing equipment without claims for additional payment.

H. These Specifications contained herein describe specific functional requirements of the door intercom as required by the owner. It is the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1.07 SUBMITTALS

A. Shop Drawings - Submit shop drawings including product data sheets and wiring diagrams per requirements in the General Conditions including the following:

   a. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Qualifications

   a. A statement of contractor's qualifications to verify compliance with other provisions within the specifications unless the contractor has been preapproved.

D. Job specific wiring diagrams.

   a. This indicates a block diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed.

   b. Riser diagram showing conduit requirements with pull boxes, outlet boxes, part numbers of cable used, and a number of circuits in each conduit.

   c. Electrical power requirements for the head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with electrical work. Electrical diagrams shall also indicate all required plug and power outlet configurations including where direct connection is required/preferred.

   d. Details of interconnection with other systems

E. Supplier shall provide rack elevations showing the configuration of all rack mounted equipment including detailed interconnection diagrams between equipment

F. 30" x 42", 24" x 36" floor plans at a scale of not less than 1/8" =1'-0" showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

G. Software data – The data package shall consist of manufacturer's data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

H. Submittals that do not contain all the required information will be REJECTED unless prior approval for partial submittals has been approved.

1.08 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.

1.09 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

2.01 MANUFACTURERS

A. Qualification of the Manufacturer:

B. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 5 years and who shall be able to refer to similar installations now rendering satisfactory service.

C. Perform all work under the on-site 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. A CSR 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.

D. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

E. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years’ experience in the manufacture of progressive products specified.

F. Approved Manufacturers:

a. Aiphone

b. Commend

c. N2

2.02 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the

removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

C. This specification is intended to establish a carefully planned minimum level of quality and performance for all components and will be rigorously enforced by Owner. Acceptable manufacturers of components described herein are:

2.03 SYSTEM DESIGN

A. Master Station(s): per drawings.

B. Audio Video Door Stations:

a. Model IX-DF - Flush Mount: Per drawings

b. Model IX-DF-HID - Flush Mount with Card Reader: Per drawings.

C. Provide Selective Door/Gate Release per drawings.

D. Provide Audio/video streaming via ONVIF Profile S.

E. Provide ONVIF Profile S camera input (max 50).

F. Provide Overhead paging.

G. Provide Contact input at door station.

2.04 FUNCTIONAL COMPONENTS:

A. As indicated on the drawings or as required to complete system.

a. 1. Video Master Station Model IX-MV:

i. An IP addressable video master station with a 3.5-inch (89 mm) color LCD monitor. 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 units. It connects directly to a network using CAT-5e/6 cable. This station requires a 802.3af compliant Power-over-Ethernet network.

b. Audio/Video Door Station Model IX-DF-HID:

i. Flush mount unit connects to a PoE network using CAT-5e/6 cable. The IXDF-HID will call up to 20 IX-MV masters or instances of the IX MOBILE. The door station features a stainless-steel face plate, an embedded ProxPointHID card reader, 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.

c. Audio/Video Door Station Model IX-DF-HID-I:

i. Flush mount unit connects to a PoE network using CAT-5e/6 cable. The IXDF-HID-I will call up to 20 IX-MV masters or instances of the IX MOBILE. The door station features a stainless-steel face plate, an embedded iClassHID card reader, 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.

d. Audio/Video Door Station Model IX-DF-2RA:

i. Flush mount unit connects to a PoE network using CAT-5e/6 cable. The IXDF-2RA will call up to 20 IX-MV masters or instances of the IX MOBILE. The door station features a stainless-steel face plate with two call buttons ("Normal" and "Emergency" Buttons can be programmed to call different master(s), Braille signage and call placed/answered indication. Additionally, the IX-DF-2RA has a form C contact for door release, two additional relays for auxiliary device control, a 600-ohm output for paging or an amplified speaker, and a contact input.

e. Audio/Video Door Station Model IX-DA:

i. Surface mount unit connects to a PoE network using CAT-5e/6 cable. The IX-DA 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.

f. Audio/Video Door Station Model IX-DF:

i. Flush mount unit connects to a PoE network using CAT-5e/6 cable. The IXDF will call up to 20 IX-MV masters or instances of the IX MOBILE. The door station features a stainless-steel face plate, 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.

g. IXW-MA IP Programmable Relay Adaptor:

i. With 4 contact inputs and 4 relay outputs

PART 3 - EXECUTION

3.01 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.

3.02 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.

C. CAT-6 Cables:

a. Run cables from and homerun to one central location where CEU will be installed.

b. Maximum Cable Runs: Keep each cable run to a maximum of 980 feet (300 m) from communication device to CEU.

c. Maintain twists of cable pairs to point of termination or no more than 0.5 inch (13 mm) untwisted.

d. Do not remove more than 1 inch (25 mm) of jacket when terminating cables.

e. Cable Bends:

i. Make gradual bends of cable, where necessary.

ii. Do not make bends of cable sharper than 1 inch (25 mm) radius.

iii. Do not allow cable to be sharply bent or kinked at any time.

f. Cable Ties: Dress cables neatly with cable ties using low to moderate pressure.

g. Cross-connect cables, where necessary, using CAT-5e rated punch blocks and components.

h. Do not splice or bridge cables.

i. Cable Pulling:

i. Pull cable with low to moderate force.

ii. Do not use oil or other lubricants not specifically designed for cable pulling.

j. Keep cables as far away from potential sources of EMI as possible.

k. Do not tie cables to electrical conduits or lay cables on electrical fixtures.

l. Cable Supports:

i. Install proper cable supports a maximum of 5 feet (1524 mm) apart.

ii. Do not support cables by ceiling tiles.

m. Label Cable Termination Points: Use unique number for each cable segment.

n. Testing Cables: Test installed cable segments with cable tester.

o. Jacks: Install jacks to prevent dust and other contaminants from settling on contacts.

p. Cable Slack:

i. Leave extra slack on cables, neatly coiled-up in ceiling or nearest concealed place.

ii. Leave a minimum of 1 foot (305 mm) of cable slack at door station side and a minimum of 10 feet 3048 mm) of cable slack at CEU side.

iii. Do not install cables taught.

iv. Grommets: Protect cables with grommets when passing through metal studs or other items that could damage cables.

v. Do not mix TIA/EIA 568A and 568B wiring on same installation. Use TIA/EIA 568B wiring throughout installation.

vi. Staples:

1. Do not use staples that crimp cables tightly.
2. Do not use T-18 and T-25 cable staples.

q. Use firestop cables that penetrate firewalls.

r. Use plenum-rated cables where mandated.

3.03 ADJUSTING

A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.04 DEMONSTRATION AND TRAINING

A. Demonstration:

a. Demonstrate that integrated security and communication system functions properly.

b. Perform demonstration at final system inspection by qualified representative of manufacturer.

B. Instruction and Training:

a. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.

b. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.

c. Provide instruction and training by qualified representative of manufacturer.

3.05 PROTECTION

A. Protect installed integrated security and communication system from damage during construction.

3.06 AS-BUILT DOCUMENTATION

A. The Contractor shall furnish the Owner digital media with complete as-built manuals and drawings in an indexed PDF file format. Drawings shall be a minimum of 11”x17” engineering format. These manuals shall contain:

a. System Operating Instructions

b. System Functional Block Diagram(s)

c. System Schematic Diagram(s)

d. System Wiring Diagrams

e. As-Built Drawings of Entire System including Equipment Rack Elevations

f. Component Technical Operation Manuals

g. Component Service Manuals

h. Software Operating Manuals

i. Port and Switch Labeling

j. Final Endurance Test Report

B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

C. The contractor shall provide a new network map indicating all new buildings included in this scope of work. Network map shall include equipment information, IP addresses, VLAN information, etc. Network map shall be prepared utilizing a computer drafting program such as AutoCAD or Visio and shall be presented in electronic format.

3.07 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

3.08 CERTIFICATION

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION

28.23.29 – VIDEO SURVEILLANCE - INDOOR

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes a 2MP IP video camera

B. Product - A 2MP IP video camera in in an IK10 rate dome body with IR illuminator.

C. Related Requirements

1.02 REFERENCES

A. Abbreviations

1.	AGC	Auto Gain Control
2.	AES	Advanced Encryption Standard
3.	AI	Artificial Intelligence
4.	API	Application Programming Interface
5.	ARP	Address Resolution Protocol
6.	AWB	Auto White Balance
7.	BLC	Back light compensation
8.	CBR	Constant Bit Rate
9.	CVBS	Composite Video Blanking and Sync
10.	DHCP	Dynamic Host Configuration Protocol
11.	DNR	Digital Noise Reduction
12.	DNS	Domain Name Server
13.	DDNS	Dynamic Domain Name Server
14.	DSCP	Differentiated Services Code Point
15.	FPS	Frames Per Second
16.	FTP	File Transfer Protocol
17.	GOV	Group of Video
18.	GUI	Graphical User Interface
19.	HD	High Definition
20.	HTTP	Hypertext Transfer Protocol
21.	HTTPS	Secure HTTP
22.	ICMP	Internet Control Message Protocol
23.	IGMP	Internet Group Management Protocol

24. IP Internet Protocol
25. IR Infrared
26. JPEG Joint Photographic Experts Group
27. LAN Local Area Network
28. LED Light Emitting Diode
29. LDC Lens Distortion Correction
30. LLDP Link Layer Discovery Protocol
31. LPR License Plate Recognition
32. MJPEG Motion JPEG
33. MP Megapixel
34. MPEG Moving Pictures Experts Group
35. NAS Network Attached Storage
36. NTP Network Time Protocol
37. NVR Network Video Recorder
38. PIM-SM Protocol Independent Multicast-Sparse Mode
39. PoE Power over Ethernet
40. PPPoE Point to Point Protocol over Ethernet
41. QoS Quality of Service
42. RTP Real-Time Transport Protocol
43. RTCP Real-Time Control Protocol
44. RTSP Real-Time Streaming Protocol
45. SDK Software Development Kit
46. SFP Small Form factor Pluggable
47. SMTP Simple Mail Transfer Protocol
48. SNMP Simple Network Management Protocol
49. SSDR Super Smart Dynamic Range
50. SSNR Super Smart Noise Reduction
51. SSL Secure Sockets Layer
52. TCP Transmission Control Protocol
53. UDP User Datagram Protocol
54. UPnP Universal Plug and Play
55. VBR Variable Bit Rate

56. VMS Video Management System
57. WDR Wide Dynamic Range

B. Reference Standards
   1. Network - IEEE
      a. 802.3 Ethernet Standards
      b. 802.1x Port-based Network Access Control
      c. IPv4 IP addressing version 4
      d. IPv6 IP addressing version 6
      e. QoS Quality of Service
   2. Video
      a. ISO / IEC 23008-2:2013, MPEG-H Part2 (ITU H.265, HEVC)
      b. ISO / IEC 14496–10, MPEG-4 Part 10 (ITU H.264)
      c. ISO / IEC 10918 – JPEG
      d. ONVIF – Profile S / G / T
   3. EMC & Safety
      a. FCC 47 CFR Part 15 Subpart B
         1) ANSI C63.4-2017 Class A
      b. IC Regulation ICES-003 Issue7
         1) CAN/CSA CISPR 32-17 Class A
      c. CE EMC-Directive 2014/30/EU and 2011/65/EU
         1) EN 55032:2015/A11:2020
         2) EN 50130-4:2011
         3) EN 610003-2:2014
         4) EN 610003-3:2013
      d. VCCI-CISPR 32:2016 Class A
      e. AS/NZS CISPR32:2015 Class A
      f. UL listed
      g. CE EN 50581:2012 (hazardous substances)
   4. Ingress Protection and Vandal Resistance
      a. 60529:2006 – Degrees of Protection Provided by Enclosures – IP66/IP67
      b. IEC EN 62262:2005 - Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts : IK10

c. NEMA 250-2014 – Enclosures for Electrical Equipment : NEMA 4X

C. Definitions

1. GOV (Group of Video object planes) – A set of video frames for H.264 and H.265 compression, indicating a collection of frames from the initial I-Frame (key frame) to the next I-Frame. GOV consists of two kinds of frames in video surveillance setup: I-Frame and P-Frame.
2. Dynamic GOV – Dynamic assignment of GOV length based on the complexity of the scene to efficiently manage bitrate of the video stream and reduce the storage required.
3. Multi-exposure wide dynamic range – Operation which automatically adjusts shutter speed to provide a wide range between dark and light areas visible at the same time, preventing backlighting issues. Long exposure is used for dark areas and a short exposure is used in bright areas.
4. Dynamic FPS – Dynamic assignment of FPS (frames per seconds) based on the movement of object(s) in the scene to efficiently manage bitrate of the video stream and reduce the storage required.
5. Smart Codec – Smart Codec that controls quantization parameter and dynamic FPS in H.265 and H.264 to efficiently manage bitrate of the video stream and reduce the storage required.
6. AI Prefer shutter – Camera should be able to intelligently control the shutter speed to obtain clearer image and to suppress image blurring when there are movements of detected objects such as humans or vehicles.
7. LDC – Lens Distortion Correction corrects image distortion at the edge of a wide-angle lens. Since Fill mode maintains the screen's top and bottom angular fields of view, the left and right end of the video could be cropped. Since Stretch mode maintains the screen's top/bottom/left/right angular fields of view, none of the areas in the original video recording is lost, but the aspect ratio of the video is not maintained.
8. DORI (Detect, Observe, Recognize, Identify) – A standard system (EN-62676-4) for defining the ability of a camera to distinguish persons or objects within a covered area.
    a. Detect: 25PPM / 8PPF
    b. Observe: 63PPM / 19PPF
    c. Recognize: 125PPM / 38PPF
    d. Identify: 250PPM / 76PPF

1.03 SUBMITTALS

A. Product Data

1. Manufacturer's printed or electronic data sheets
2. Manufacturer's installation and operation manuals
3. Warranty documentation

1.04 QUALIFICATIONS

A. Manufacturer shall have a minimum of five years' experience in producing IP video equipment.

B. Installers shall be trained and authorized by the Manufacturer to install, integrate.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver the camera in the manufacturer's original, unopened, undamaged container with identification labels intact.

B. Store the camera in a temperature environment specified in section 2.04 Detailed Specification, protected from mechanical and environmental conditions as designated by the manufacturer.

1.06 WARRANTY, LICENSING AND SUPPORT

A. Manufacturer shall provide at least a limited 3 year warranty for the product to be free of defects in material and workmanship.

B. Manufacturer shall provide embedded camera video analytics free of license charges.

PART 2 PRODUCTS

2.01 GENERAL DESCRIPTION

A. Video Compression and Transmission – The camera shall have the following properties relating to the video signals it produces.

1. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
    a. H.265 and H.264 : Max. 60/50fps(60Hz/50Hz)
    b. MJPEG : Max. 30fps/25fps(60Hz/50Hz)
2. The camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
3. The camera shall be able to configure various resolution selections.
    a. 16:9 aspect ratio: 1920x1080, 1280x720, 800x448, 640x360
    b. 4:3 aspect ratio: 1280x960, 1024x768, 800x600, 640x480, 320x240
    c. 5:4 aspect ratio: 1280x1024, 720x576
    d. 3:2 aspect ratio: 720x480
4. The camera shall support unicast video streaming up to 20 users.
5. The camera shall support multicast video streaming.
6. The camera shall support multiple video streaming up to 10 profiles.
7. The camera shall support 3 virtual channel support.

8. The camera shall be able to configure Dynamic DNS (DDNS). DDNS shall be provided with no additional cost by the manufacturer.

B. Camera – The camera device shall have the following physical and performance properties:
   1. IK08 rated for protection against impacts.
   2. True day/night operation with scheduling and options for external devices.
      a. Low light level operation to 0.011 lux(30fps/25fps)/0.022lux(60fps/50fps) at F1.4 in color mode, 0.0011 lux(30fps/25fps)/0.0022lux(60fps/50fps) in black and white mode.
      b. Black and white mode operation to 0 lux with IR LED on.
   3. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range up to 150dB.
   4. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range.
   5. The camera shall be able to configure 32 privacy masking areas with quadrangle zones.
   6. The camera shall have the defog feature to remove fogginess of scene which can be triggered automatically from the fog detection event.
   7. The camera shall provide video display on smart phone (iPhone, Android) to adjust viewing angle, rotation, and focus.

C. Intelligence and Analytics – The camera shall have a suite of intelligent analytic functions.
   1. Analytics events based on AI engine
      a. Object detection: Person/Face/Vehicle(car/truck/bus/bicycle/motorcycle)/License plate
      b. IVA: Virtual line/Area, Enter/Exit, Loitering, direction, intrusion
   2. Analytics events: Defocus detection, Motion detection, Tampering, Fog detection, Audio detection, Sound classification, Shock detection, Appear/Disappear
      a. Motion detection with 8 definable detection areas with 8 point polygonal zones, and minimum/maximum object size.
      b. Detection and classification of the following sound.
         1) Scream
         2) Gunshot
         3) Explosion
         4) Crashing glass
   3. Business Intelligence: Based on AI engine
      a. People counting
      b. Queue management

c. Heatmap

D. Interoperability – The camera shall be ONVIF Profile S / G and T compliant.

E. The camera shall possess the following further characteristics

1. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
2. NAS recording option with configurable pre-alarm and post-alarm recording intervals
3. Alarms and notifications
   a. alarm notification triggers
      1) Analytics
      2) Networks disconnect
      3) Alarm input
      4) App event
      5) Time schedule
   b. available notification means upon trigger
      1) File upload(image): e-mail/FTP
      2) Notification: e-mail
      3) Recording: SD/SDHC/SDXC or NAS recording at event triggers
      4) Alarm output
      5) Handover (PTZ preset, Send message by HTTP/HTTPS/TCP)
      6) Audio clip playback
4. Pixel Counter available in the web viewer.
5. IP52/IK08
6. This device has been verified using STP cable. The use of appropriate GND grounding and STP cable is recommended to effectively protect your product and property from transient voltage, thunder stroke, communication interruption.
7. NDAA Compliant

2.02 CAMERA SOFTWARE

A. The camera shall have a built-in web server.

B. The web viewer shall provide a monitoring screen which displays live camera video and simultaneously provides same-screen access to the following functions:

1. Live view window size
2. Resolution setting

3. Image (snapshot) capture
4. Manual recording to SD or NAS
5. Audio/microphone control
6. Access recorded data playback and camera configuration menus

C. The web viewer shall provide a playback screen which provides access to the following functions:
   1. Recorded data search using date and time range
   2. Recorded data search using event type
   3. Play a recorded video by event triggering
   4. Set playback speed
   5. Play audio if present
   6. Generate a backup copy of saved video data

D. The web viewer shall provide a setup screen which provides access to the following configuration settings and functions in the camera:
   1. Digital video profile to include compression type, maximum or target bit rate, frame rate, multicast parameters, and crop encoding area
   2. User profile to include password, access level, authentication
   3. Date and time
   4. Network settings and IP version
      a. DDNS
      b. IP filtering
      c. SSL/TLS, including certificate management
      d. 802.1x authentication
      e. Quality of Service settings
      f. SNMP to include version selection and settings
      g. Auto IP configuration
   5. Video setup
      a. Flip / mirror mode
      b. Video output type
      c. Privacy zone
   6. Audio setup to include source, audio codec type, gain and bit rate.
   7. Camera settings to configure image preset, sensor frame capture, dynamic range, white balance, back light, exposure, day/night operation, on-screen display, sharpness, contrast, color level and lens distortion correction.

8. Event detection setup to configure notification parameters, recording rules, time schedule, tamper protection, motion detection and event triggers
9. System function to control reboot, upgrade, check system and event logs and application (SDK) management
10. View profile information

2.03 DETAILED SPECIFICATIONS

A. Video

1. Imaging device: 1/2.8" CMOS
2. Scanning: Progressive
3. Minimum Illumination
    a. 30/25fps
        1) Color: 0.011Lux (F1.4, 1/30sec, 30IRE)
        2) B/W: 0.0011Lux (F1.4, 1/30sec, 30IRE), 0Lux (IR ILED On)
    b. 60/50fps
        1) Color: 0.022Lux (F1.4, 1/30sec, 30IRE)
        2) B/W: 0.0022Lux (F1.4, 1/30sec, 30IRE), 0Lux (IR ILED On)
4. Video out for installation
    a. USB: Micro USB Type B, 1280x720

B. Lens

1. Focal length: 2.8~12mm (4.3x) motorized varifocal
2. Max. Aperture Ratio: F1.4(Wide) ~ F3.6(Tele)
3. Field of View
    a. H: 119.5°(Wide)~27.9°(Tele)
    b. V: 62.8°(Wide)~15.7°(Tele)
    c. D: 142.1°(Wide)~32.0°(Tele)
4. Min. Object Distance: 0.5m(1.64ft)
5. Focus Control: Simple focus, Manual
6. Lens Type : DC auto iris with hall sensor (IR corrected)

C. Pan & Tilt & Rotate

1. PTR Range: 0°~360° / -45°~75° / 0°~355°

D. Operational Functions

1. IR Viewable Length: 40m(131.23ft)

2. Camera Title
    a. Off / On (Displayed up to 85 characters)
    b. English / Numeric / Special characters
    c. Multi-line (Max. 5lines), Color (Grey / Green / Red / Blue / Black / White), Transparency, Auto scale by resolution
3. Day/Night Setting: Auto (ICR) / Color / B/W / Schedule
4. Backlight Compensation: Off / BLC / HLC / extremeWDR(150dB)
5. Contrast Enhancement: SSDR
6. Digital Image Stabilization: Support (built-in gyro sensor)
7. Defog: Support
8. Motion Detection: Off / On (8ea, 8-point polygonal)
9. Privacy Masking: Off / On (32ea, Quadrangle zones)
    a. Color: Grey / Green / Red / Blue / Black / White
    b. Mosaic
10. Gain Control: Off / Manual / Max Gain
11. White Balance: ATW / Narrow ATW / AWC / Manual / Indoor / Outdoor
12. LDC: Support (Fill/stretch mode)
13. Electronic Shutter Speed: Min / Max / Anti-flicker (2 ~ 1/12,000sec)
    a. Prefer shutter control (Based on AI engine)
14. Image Rotation
    a. Flip: Off / On
    b. Mirror: Off / On
    c. Hallway view (90°/270°)
15. Digital PTZ: Support
16. Alarm I/O: 2 configurable I/O ports
17. Alarm Triggers
    a. Analytics
    b. Networks disconnect
    c. Alarm input
    d. App event
    e. Time schedule
18. Alarm Events

a. File upload(image): e-mail/FTP
b. Notification: e-mail
c. Recording: SD/SDHC/SDXC or NAS recording at event triggers
d. Alarm output
e. Handover (PTZ preset, Send message by HTTP/HTTPS/TCP)
f. Audio clip playback

19. Pixel Counter: Support
20. Storage: Micro SD/SDHC/SDXC 1slot 512GB
21. Analytics: Analytics events based on AI engine
    a. Object detection: Person/Face/Vehicle (car/truck/bus/bicycle/motorcycle)/License plate
    b. IVA: Virtual line/Area, Enter/Exit, Loitering, direction, intrusion
22. Business Intelligence: Based on AI engine
    a. People counting
    b. Queue management
    c. Heatmap
23. Analytics events: Defocus detection, Motion detection, Tampering, Fog detection, Audio detection, Sound classification, Shock detection, Appear/Disappear
24. Memory: 2GB RAM, 512MB Flash

E. Video Streams
1. Video compression : H.265, H.264, MJPEG
2. Resolution: 1920x1080, 1280x1024,1280x960, 1280x720, 1024x768, 800x600, 800x448, 720x576, 720x480, 640x480, 640x360, 320x240
3. Maximum Framerate
    a. H.265 / H.264: Max. 60fps/35fps(60Hz/50Hz)
    b. MJPEG: Max. 30fps/25fps(60Hz/50Hz)
4. Smart Codec
    a. Manual (5ea area)
5. Bitrate Control Method
    a. H.265 / H.264: CBR or VBR
    b. MJPEG: VBR
6. Streaming Capability: Unicast (20 users) / Multicast, Multiple streaming (Up to 10 profiles, 3 virtual channel support)

7. Streaming method : Unicast / Multicast
8. Simultaneous Users: 20 maximums (Unicast)
9. Profile set : Max. 10 ea.
10. Interoperability
    a. ONVIF Profile S / G / T
    b. SUNAPI (HTTP API)

F. Audio
1. Audio In
    a. Selectable (mic in/line in)
    b. Supply voltage: 2.5V DC (4mA)
    c. Input impedance: 2K Ohm
2. Audio Out
    a. Line out
    b. Max Output level 1Vrms
3. Audio Compression
    a. G.711 u-law /G.726 Selectable
    b. G.726 (ADPCM) 8KHz, G.711 8KHz
    c. G.726: 16Kbps, 24Kbps, 32Kbps, 40Kbps
    d. AAC-LC: 48Kbps at 16KHz

G. Network
1. Connectivity: Metal shielded RJ-45(10/100/1000BASE-T)
2. Protocol
    a. IP v4 / v6, TCP, UDP
    b. Configuration: DHCP, LLDP
    c. Web service: HTTP, HTTPS
    d. Network Service: ARP, Bonjour, DNS, ICMP, NTP, PIM-SM, SNMPv1/v2c/v3(MIB-2), UPnP
    e. Media: RTP, RTCP, RTSP
    f. Unicast: SRTP
    g. Multicast: IGMP, PIM-SM
    h. Notifications: FTP, SMTP
3. DDNS – The camera shall support DDNS services offered by the manufacturer and others publicly available service offerings

4. QoS – Layer 3 DSCP
5. Security Feature
    a. UL-CAP Certified
    b. User password protection
    c. The device shall not provide a manufacture default password. Initial password setting shall be required to access the camera.
    d. A minimal level of password complexity shall be required by the camera.
    e. The camera shall not have a manufacture back-door password.
    f. The manufacturer shall provide a tool that provides the ability to make password changes to multiple cameras at the same time.
    g. IP address filtering – List of allowed or blocked IP addresses.
    h. SRTP secured video communication for multicast.
    i. Digest login authentication.
    j. User access log.
    k. 802.1X Authentication (EAP-TLS, EAP-LEAP)
    l. HTTPS(SSL/TLS) login authentication and secured video communication with TLS v1.3
    m. Disk encryption on SD card recording (AES-256)
    n. File encryption on local disk recording via web browser (AES-256)
    o. Mutual Authentication (Client Authentication) for secure communication
    p. Secure OS and Security Boot
6. Discovery – The manufacturer shall offer a discovery program to identify all devices of them on the network.
7. Configuration – The manufacturer shall offer a configuration program that remotely allows users to change settings on multiple cameras simultaneously.
8. Firmware upgrade – The manufacturer shall offer a program capable of upgrading multiple cameras at the same time (not requiring access to individual cameras).
9. Camera backup setting – The manufacturer shall provide a program that provides the ability to save multiple camera settings to a file and restore these camera settings if needed.
10. Reporting – The manufacturer shall provide a tool that can generate a report including thumbnail view, MAC address, IP address, serial number and other camera settings.

H. Electrical
    1. Power
        a. Input Voltage

1) PoE(IEEE802.3af, Class3)
2) 12VDC

b. Power Consumption
1) PoE: Max 12.95W, typical 11.2W
2) 12VDC: Max 13.2W, typical 10.8W

I. Mechanical And Environmental
1. Color/Material
a. White / Aluminum + PC
b. Hard-coated dome bubble
2. RAL Code: RAL9003
3. Dimensions (W x H): Ø160x118mm (Ø6.30x4.65")
4. Weight: 1,350g (2.98 lb.)
5. Temperature
a. Operating: -10 °C ~ 50 °C (-14°F ~ +122°F)
1) Maximum temperature: +55°C (intermittent)
b. Storage: -50°C ~ +60°C(-58°F ~ +140°F)
6. Humidity
a. Operating: Less than 95% RH (non-condensing)
1) Humidity control /w GORE vent
b. Storage: Less than 90% RH (non-condensing)
7. Ingression Protection: IP52
8. Vandal Resistance : IK08

J. DORI
1. Detect (25PPM/ 8PPF): Wide: 22.4m(73.47ft) / Tele: 154.6m(507.18ft)
2. Observe (63PPM/ 19PPF): Wide: 9.0m(29.39ft) / Tele: 61.8m(202.87ft)
3. Recognize (125PPM/ 38PPF): Wide: 4.5m(14.69ft) / Tele: 30.9m(101.44ft)
4. Identify (250PPM/ 76PPF): Wide: 2.2m(7.35ft) / Tele: 15.5m(50.72ft)

K. EMC & Safety
1. FCC 47 CFR Part 15 Subpart B
a. ANSI C63.4-2017 Class A
2. IC Regulation ICES-003 Issue7
a. CAN/CSA CISPR 32-17 Class A

3. CE EMC-Directive 2014/30/EU and 2011/65/EU
    a. EN 55032:2015/A11:2020
    b. EN 50130-4:2011
    c. EN 610003-2:2014
    d. EN 610003-3:2013
4. VCCI-CISPR 32:2016 Class A
5. AS/NZS CISPR32:2015 Class A
6. UL listed
7. CE EN 50581:2012 (hazardous substances)

PART 3 EXECUTION

3.01 INSTALLERS

A. Contractor personnel shall comply with all applicable state and local licensing requirements.

3.02 PREPARATION

A. The network design and configuration shall be verified for compatibility and performance with the camera(s).

B. Network configuration shall be tested and qualified by the Contractor prior to camera installation.

C. All firmware found in products shall be the latest and the most up to date provided by the manufacturer, or of a version as specified by the provider of the VMS or NVR.

D. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

3.03 INSTALLATION

A. The contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.

B. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.

C. Before permanent installation of the system, the contractor shall test the system in conditions simulating the final installed environment.

3.04 STORAGE

A. The hardware shall be stored in an environment where temperature and humidity are in the range specified by the manufacturer.

3.05 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer, and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

28.23.30 – VIDEO SURVEILLANCE - OUTDOOR

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes a 2MP IP video camera

B. Product - A 2MP IP video camera in in an IK10 rate dome body with IR illuminator.

C. Related Requirements

1.02 REFERENCES

A. Abbreviations

1.	AGC	Auto Gain Control
2.	AES	Advanced Encryption Standard
3.	AI	Artificial Intelligence
4.	API	Application Programming Interface
5.	ARP	Address Resolution Protocol
6.	AWB	Auto White Balance
7.	BLC	Back light compensation
8.	CBR	Constant Bit Rate
9.	CVBS	Composite Video Blanking and Sync
10.	DHCP	Dynamic Host Configuration Protocol
11.	DNR	Digital Noise Reduction
12.	DNS	Domain Name Server
13.	DDNS	Dynamic Domain Name Server
14.	DSCP	Differentiated Services Code Point
15.	FPS	Frames Per Second
16.	FTP	File Transfer Protocol
17.	GOV	Group of Video
18.	GUI	Graphical User Interface
19.	HD	High Definition
20.	HTTP	Hypertext Transfer Protocol
21.	HTTPS	Secure HTTP
22.	ICMP	Internet Control Message Protocol
23.	IGMP	Internet Group Management Protocol
24.	IP	Internet Protocol

25.	IR	Infrared
26.	JPEG	Joint Photographic Experts Group
27.	LAN	Local Area Network
28.	LED	Light Emitting Diode
29.	LDC	Lens Distortion Correction
30.	LLDP	Link Layer Discovery Protocol
31.	LPR	License Plate Recognition
32.	MJPEG	Motion JPEG
33.	MP	Megapixel
34.	MPEG	Moving Pictures Experts Group
35.	NAS	Network Attached Storage
36.	NTP	Network Time Protocol
37.	NVR	Network Video Recorder
38.	PIM-SM	Protocol Independent Multicast-Sparse Mode
39.	PoE	Power over Ethernet
40.	PPPoE	Point to Point Protocol over Ethernet
41.	QoS	Quality of Service
42.	RTP	Real-Time Transport Protocol
43.	RTCP	Real-Time Control Protocol
44.	RTSP	Real-Time Streaming Protocol
45.	SDK	Software Development Kit
46.	SFP	Small Form factor Pluggable
47.	SMTP	Simple Mail Transfer Protocol
48.	SNMP	Simple Network Management Protocol
49.	SSDR	Super Smart Dynamic Range
50.	SSNR	Super Smart Noise Reduction
51.	SSL	Secure Sockets Layer
52.	TCP	Transmission Control Protocol
53.	UDP	User Datagram Protocol
54.	UPnP	Universal Plug and Play
55.	VBR	Variable Bit Rate
56.	VMS	Video Management System
57.	WDR	Wide Dynamic Range

B. Reference Standards

1. Network - IEEE
    a. 802.3 Ethernet Standards
    b. 802.1x Port-based Network Access Control
    c. IPv4 IP addressing version 4
    d. IPv6 IP addressing version 6
    e. QoS Quality of Service
2. Video
    a. ISO / IEC 23008-2:2013, MPEG-H Part2 (ITU H.265, HEVC)
    b. ISO / IEC 14496–10, MPEG-4 Part 10 (ITU H.264)
    c. ISO / IEC 10918 – JPEG
    d. ONVIF – Profile S / G / T
3. EMC & Safety
    a. FCC 47 CFR Part 15 Subpart B
        1) ANSI C63.4-2017 Class A
    b. IC Regulation ICES-003 Issue7
        1) CAN/CSA CISPR 32-17 Class A
    c. CE EMC-Directive 2014/30/EU and 2011/65/EU
        1) EN 55032:2015/A11:2020
        2) EN 50130-4:2011
        3) EN 610003-2:2014
        4) EN 610003-3:2013
    d. VCCI-CISPR 32:2016 Class A
    e. AS/NZS CISPR32:2015 Class A
    f. UL listed
    g. CE EN 50581:2012 (hazardous substances)
4. Ingress Protection and Vandal Resistance
    a. 60529:2006 – Degrees of Protection Provided by Enclosures – IP66/IP67
    b. IEC EN 62262:2005 - Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts: IK10
    c. NEMA 250-2014 – Enclosures for Electrical Equipment: NEMA 4X

C. Definitions

1. GOV (Group of Video object planes) – A set of video frames for H.264 and H.265 compression, indicating a collection of frames from the initial I-Frame (key frame) to the next I-Frame. GOV consists of two kinds of frames in video surveillance setup: I-Frame and P-Frame.
2. Dynamic GOV – Dynamic assignment of GOV length based on the complexity of the scene to efficiently manage bitrate of the video stream and reduce the storage required.
3. Multi-exposure wide dynamic range – Operation which automatically adjusts shutter speed to provide a wide range between dark and light areas visible at the same time, preventing backlighting issues. Long exposure is used for dark areas and a short exposure is used in bright areas.
4. Dynamic FPS – Dynamic assignment of FPS (frames per seconds) based on the movement of object(s) in the scene to efficiently manage bitrate of the video stream and reduce the storage required.
5. Smart Codec – Smart Codec that controls quantization parameter and dynamic FPS in H.265 and H.264 to efficiently manage bitrate of the video stream and reduce the storage required.
6. AI Prefer shutter – Camera should be able to intelligently control the shutter speed to obtain clearer image and to suppress image blurring when there are movements of detected objects such as humans or vehicles.
7. LDC – Lens Distortion Correction corrects image distortion at the edge of a wide-angle lens. Since Fill mode maintains the screen's top and bottom angular fields of view, the left and right end of the video could be cropped. Since Stretch mode maintains the screen's top/bottom/left/right angular fields of view, none of the areas in the original video recording is lost, but the aspect ratio of the video is not maintained.
8. DORI (Detect, Observe, Recognize, Identify) – A standard system (EN-62676-4) for defining the ability of a camera to distinguish persons or objects within a covered area.
    a. Detect: 25PPM / 8PPF
    b. Observe: 63PPM / 19PPF
    c. Recognize: 125PPM / 38PPF
    d. Identify: 250PPM / 76PPF

1.03 SUBMITTALS

A. Product Data
    1. Manufacturer's printed or electronic data sheets
    2. Manufacturer's installation and operation manuals
    3. Warranty documentation

1.04 QUALIFICATIONS

A. Manufacturer shall have a minimum of five years' experience in producing IP video equipment.

B. Installers shall be trained and authorized by the Manufacturer to install, integrate.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver the camera in the manufacturer's original, unopened, undamaged container with identification labels intact.

B. Store the camera in a temperature environment specified in section 2.04 Detailed Specification, protected from mechanical and environmental conditions as designated by the manufacturer.

1.06 WARRANTY, LICENSING AND SUPPORT

A. Manufacturer shall provide at least a limited 3-year warranty for the product to be free of defects in material and workmanship.

B. Manufacturer shall provide embedded camera video analytics free of license charges.

PART 2 PRODUCTS

2.01 GENERAL DESCRIPTION

A. Video Compression and Transmission – The camera shall have the following properties relating to the video signals it produces.

1. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
    a. H.265 and H.264 – maximum of 30/25fps(60Hz/50Hz) at all resolution
    b. MJPEG – maximum of 15fps/12fps(60Hz/50Hz)
2. The camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
3. The camera shall be able to configure various resolution selections.
    a. 16:9 aspect ratio: 1920x1080, 1280x720, 800x448, 640x360
    b. 4:3 aspect ratio: 1280x960, 1024x768, 800x600, 640x480, 320x240
    c. 5:4 aspect ratio: 1280x1024, 720x576
    d. 3:2 aspect ratio: 720x480
4. The camera shall support unicast video streaming up to 20 users.
5. The camera shall support multicast video streaming.
6. The camera shall support multiple video streaming up to 10 profiles.
7. The camera shall support 3 virtual channel support.
8. The camera shall be able to configure Dynamic DNS (DDNS). DDNS shall be provided with no additional cost by the manufacturer.

B. Camera – The camera device shall have the following physical and performance properties:

1. IK08 rated for protection against impacts.
2. True day/night operation with scheduling and options for external devices.
    a. Low light level operation to 0.011 lux(30fps/25fps)/0.022lux(60fps/50fps) at F1.4 in color mode, 0.0011 lux(30fps/25fps)/0.0022lux(60fps/50fps) in black and white mode.
    b. Black and white mode operation to 0 lux with IR LED on.
3. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range up to 150Db.
4. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range.
5. The camera shall be able to configure 32 privacy masking areas with quadrangle zones.
6. The camera shall have the defog feature to remove fogginess of scene which can be triggered automatically from the fog detection event.
7. The camera shall provide video display on smart phone (iPhone, Android) to adjust viewing angle, rotation, and focus.

C. Intelligence and Analytics – The camera shall have a suite of intelligent analytic functions.
    1. Analytics events based on AI engine: Object detection

    (Person/Face/Vehicle(car/truck/bus/bicycle/motorcycle)/License plate), IVA (Virtual line/Area, Enter/Exit, Loitering, direction, intrusion)
    2. Analytics events: Defocus detection, Motion detection, Tampering, Fog detection, Audio detection, Sound classification, Shock detection, Appear/Disappear
        a. Motion detection with 8 definable detection areas with 8 point polygonal zones, and minimum/maximum object size.
        b. Detection and classification of the following sound.
            1) Scream
            2) Gunshot
            3) Explosion
            4) Crashing glass
    3. Business Intelligence: People counting, Queue management, Heatmap(based on AI engine)

D. Interoperability – The camera shall be ONVIF Profile S / G and T compliant.

E. The camera shall possess the following further characteristics:
    1. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
    2. NAS recording option with configurable pre-alarm and post-alarm recording intervals
    3. Alarms and notifications

a. alarm notification triggers:
    1) Analytics
    2) Networks disconnect
    3) Alarm input
    4) App event
    5) Time schedule
b. available notification means upon trigger:
    1) File upload(image): e-mail/FTP
    2) Notification: e-mail
    3) Recording: SD/SDHC/SDXC or NAS recording at event triggers
    4) Alarm output
    5) Handover (PTZ preset, Send message by HTTP/HTTPS/TCP)
    6) Audio clip playback

4. Pixel Counter available in the web viewer.
5. IP52/IK08
6. This device has been verified using STP cable. The use of appropriate GND grounding and STP cable is recommended to effectively protect your product and property from transient voltage, thunderstroke, communication interruption.

2.02 CAMERA SOFTWARE

A. The camera shall have a built-in web server.

B. The web viewer shall provide a monitoring screen which displays live camera video and simultaneously provides same-screen access to the following functions:
    1. Live view window size
    2. Resolution setting
    3. Image (snapshot) capture
    4. Manual recording to SD or NAS
    5. Audio/microphone control
    6. Access recorded data playback and camera configuration menus

C. The web viewer shall provide a playback screen which provides access to the following functions:
    1. Recorded data search using date and time range
    2. Recorded data search using event type
    3. Play a recorded video by event triggering
    4. Set playback speed

5. Play audio if present
6. Generate a backup copy of saved video data

D. The web viewer shall provide a setup screen which provides access to the following configuration settings and functions in the camera:

1. Digital video profile to include compression type, maximum or target bit rate, frame rate, multicast parameters, and crop encoding area
2. User profile to include password, access level, authentication
3. Date and time
4. Network settings and IP version
    a. DDNS
    b. IP filtering
    c. SSL/TLS, including certificate management
    d. 802.1x authentication
    e. Quality of Service settings
    f. SNMP to include version selection and settings
    g. Auto IP configuration
5. Video setup
    a. Flip / mirror mode
    b. Video output type
    c. Privacy zone
6. Audio setup to include source, audio codec type, gain and bit rate.
7. Camera settings to configure image preset, sensor frame capture, dynamic range, white balance, back light, exposure, day/night operation, on-screen display, sharpness, contrast, color level and lens distortion correction.
8. Event detection setup to configure notification parameters, recording rules, time schedule, tamper protection, motion detection and event triggers
9. System function to control reboot, upgrade, check system and event logs and application (SDK) management
10. View profile information

2.03 DETAILED SPECIFICATIONS

A. Video

1.	Imaging device	1/2.8" CMOS
2.	Scanning	Progressive

3.	Minimum Illumination	Color: 0.011Lux (F1.4, 1/30sec, 30IRE), 30/25fps
		B/W: 0.0011Lux (F1.4, 1/30sec, 30IRE), 0Lux (IR ILED On),30/25fps
		Color: 0.022Lux (F1.4, 1/30sec, 30IRE), 60/50fps
		B/W: 0.0022Lux (F1.4, 1/30sec, 30IRE), 0Lux (IR ILED On),60/50fps
4.	Video out	USB: Micro USB Type B, 1280x720 for installation

B. Lens

1.	Focal length	2.8~12mm (4.3x) motorized varifocal
2.	Max. Aperture Ratio	F1.4(Wide) ~????????
3.	Field of View	H: 119.5°(Wide)~27.9°(Tele)
		V: 62.8°(Wide)~15.7°(Tele)
		D: 142.1°(Wide)~32.0°(Tele)
4.	Min. Object Distance	0.5m(1.64ft)
5.	Focus Control	Simple focus, Manual
6.	Lens Type	DC auto iris with hall sensor (IR corrected)

C. Pan & Tilt & Rotate

1.	PTR Range	0°~360° / -45°~75° / 0°~355°

D. Operational Functions

1.	IR Viewable Length	40m(131.23ft)
2.	Camera Title	Off / On (Displayed up to 85 characters)
3.	Day/Night Setting	Auto (ICR) / Color / B/W / Schedule
4.	Backlight Compensation	Off / BLC / HLC / extremeWDR(150dB)
5.	Contrast Enhancement	SSDR
6.	Digital Image Stabilization	Support (built-in gyro sensor)
7.	Defog	Support
8.	Motion Detection	Off / On (8ea, 8-point polygonal)
9.	Privacy Masking	Off / On (32ea, Quadrangle zones)
		- Color: Grey / Green / Red / Blue / Black / White
		- Mosaic
10.	Gain Control	Off / Manual / Max Gain
11.	White Balance	ATW / Narrow ATW / AWC / Manual / Indoor / Outdoor
12.	LDC	Support (Fill/stretch mode)
13.	Electronic Shutter Speed	Min / Max / Anti-flicker (2 ~ 1/12,000sec)
		Prefer shutter control (Based on AI engine)

14.	Image Rotation	Flip: Off / On Mirror: Off / On Hallway view (90°/270°)
15.	Digital PTZ	Support
16.	Alarm I/O	2 configurable I/O ports
17.	Alarm Triggers	Analytics, Network disconnect, Alarm input, App event, Time schedule
18.	Alarm Events	File upload(image): e-mail/FTP Notification: e-mail Recording: SD/SDHC/SDXC or NAS recording at event triggers Alarm output Handover (PTZ preset, Send message by HTTP/HTTPS/TCP) Audio clip playback
19.	Pixel Counter	Support
20.	Storage	Micro SD/SDHC/SDXC 1slot 512GB
21.	Analytics	Analytics events based on AI engine: Object detection (Person/Face/Vehicle (car/truck/bus/bicycle/motorcycle)/ License plate), IVA (Virtual line/Area, Enter/Exit, Loitering, direction, intrusion)
22.	Business Intelligence	Based on AI engine: People counting, Queue management, Heatmap
23.	Analytics events	Defocus detection, Motion detection, Tampering, Fog detection, Audio detection, Sound classification, Shock detection, Appear/Disappear
24.	Memory	2.8~12mm (4.3x) motorized varifocal
25.	Max. Aperture Ratio	F1.4(Wide) ~????????
26.	Field of View	H: 119.5°(Wide)~27.9°(Tele) V: 62.8°(Wide)~15.7°(Tele) D: 142.1°(Wide)~32.0°(Tele)

E. Video Streams

1.	Video compression	H.265, H.264, MJPEG
2.	Resolution	1920x1080, 1280x1024,1280x960, 1280x720, 1024x768, 800x600, 800x448, 720x576, 720x480, 640x480, 640x360, 320x240

3. Maximum Framerate
    a. H.265 / H.264 — Max. 60fps/35fps(60Hz/50Hz)
    b. MJPEG — Max. 30fps/25fps(60Hz/50Hz)
4. Smart Codec — Manual (5ea area)
5. Bitrate Control Method — H.265 / H.264: CBR or VBR; MJPEG: VBR
6. Streaming Capability — Unicast (20 users) / Multicast; Multiple streaming (Up to 10 profiles, 3 virtual channel support)
7. Streaming method — Unicast / Multicast
8. Simultaneous Users — 20 maximum (Unicast)
9. Profile set — Max. 10 ea
10. Interoperability — ONVIF Profile S / G / T, SUNAPI (HTTP API),

F. Audio

1. Audio In — Selectable (mic in/line in); Supply voltage: 2.5V DC (4mA), Input impedance: 2K Ohm
2. Audio Out — Line out, Max. output level 1Vrms
3. Audio Compression — G.711 u-law /G.726 Selectable; G.726 (ADPCM) 8KHz, G.711 8KHz; G.726: 16Kbps, 24Kbps, 32Kbps, 40Kbps; AAC-LC: 48Kbps at 16KHz

G. Network

1. Connectivity
    a. Metal shielded RJ-45(10/100/1000BASE-T)
2. Protocol
    a. IP v4 / v6, TCP, UDP
    b. Configuration: DHCP, LLDP
    c. Web service: HTTP, HTTPS
    d. Network Service: ARP, Bonjour, DNS, ICMP, NTP, PIM-SM, SNMPv1/v2c/v3(MIB-2), UPnP
    e. Media: RTP, RTCP, RTSP
    f. Unicast: SRTP
    g. Multicast: IGMP, PIM-SM
    h. Notifications: FTP, SMTP

3. DDNS – The camera shall support DDNS services offered by the manufacturer and others publicly available service offerings
4. QoS – Layer 3 DSCP
5. Security Feature
    a. UL-CAP Certified
    b. User password protection
    c. The device shall not provide a manufacture default password. Initial password setting shall be required to access the camera.
    d. A minimal level of password complexity shall be required by the camera.
    e. The camera shall not have a manufacture back-door password.
    f. The manufacturer shall provide a tool that provides the ability to make password changes to multiple cameras at the same time.
    g. IP address filtering – List of allowed or blocked IP addresses.
    h. SRTP secured video communication for multicast.
    i. Digest login authentication.
    j. User access log.
    k. 802.1X Authentication (EAP-TLS, EAP-LEAP)
    l. HTTPS(SSL/TLS) login authentication and secured video communication with TLS v1.3
    m. Disk encryption on SD card recording (AES-256)
    n. File encryption on local disk recording via web browser (AES-256)
    o. Mutual Authentication (Client Authentication) for secure communication
    p. Secure OS and Security Boot
6. Discovery – The manufacturer shall offer a discovery program to identify all devices of them on the network.
7. Configuration – The manufacturer shall offer a configuration program that remotely allows users to change settings on multiple cameras simultaneously.
8. Firmware upgrade – The manufacturer shall offer a program capable of upgrading multiple cameras at the same time (not requiring access to individual cameras).
9. Camera backup setting – The manufacturer shall provide a program that provides the ability to save multiple camera settings to a file and restore these camera settings if needed.
10. Reporting – The manufacturer shall provide a tool that can generate a report including thumbnail view, MAC address, IP address, serial number, and other camera settings.

H. Electrical
    1. Power

a. Input Voltage	PoE (IEEE802.3af, Class3), 12VDC
b. Power Consumption	PoE: Max 12.95W, typical 11.2W
	12VDC: Max 13.2W, typical 10.8W

I. Mechanical And Environmental

1. Color/Material	White / Aluminum
	Hard-coated dome bubble
2. RAL Code	RAL9003
3. Dimensions (W x H)	Ø160x118mm (Ø6.30x4.65")
4. Weight	1,450g (3.20 lb)
5. Compatible Conduit hole / Gangbox	1/2” (M20)
	Single, double, 4” octagon, 4” square
6. Hanging Mount (Dome)	SBP-167HMW
7. Weater Cap (Dome)	SBV-161WCW
8. Temperature	
a. Operating	-40 °C ~ 55 °C (40°F ~ +131°F)
	* Maximum temperature: +60°C (intermittent)
	* Start up should be done at above -20°C
	NEMA TS-2: 74°C
b. Storage	-50°C ~ +60°C (-58°F ~ +140°F)
9. Humidity	
a. Operating	Less than 95% RH (non-condensing)
	Humidity control /w GORE vent
b. Storage	Less than 90% RH (non-condensing)
10. Ingression Protection	IP66/IP67/NEMA4X
11. Vandal Resistance	IK10

J. DORI

1. Detect (25PPM/ 8PPF)	Wide: 22.4m(73.47ft) / Tele: 154.6m(507.18ft)
2. Observe (63PPM/ 19PPF)	Wide: 9.0m(29.39ft) / Tele: 61.8m(202.87ft)
3. Recognize (125PPM/ 38PPF)	Wide: 4.5m(14.69ft) / Tele: 30.9m(101.44ft)
4. Identify (250PPM/ 76PPF)	Wide: 2.2m(7.35ft) / Tele: 15.5m(50.72ft)

PART 3 EXECUTION

3.01 INSTALLERS

A. Contractor personnel shall comply with all applicable state and local licensing requirements.

3.02 PREPARATION

A. The network design and configuration shall be verified for compatibility and performance with the camera(s).

B. Network configuration shall be tested and qualified by the Contractor prior to camera installation.

C. All firmware found in products shall be the latest and the most up to date provided by the manufacturer, or of a version as specified by the provider of the VMS or NVR.

D. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

3.03 INSTALLATION

A. The contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.

B. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.

C. Before permanent installation of the system, the contractor shall test the system in conditions simulating the final installed environment.

3.04 STORAGE

A. The hardware shall be stored in an environment where temperature and humidity are in the range specified by the manufacturer.

3.05 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer, and Architect. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

END OF SECTION

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 284600 - ADDRESSABLE FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 “General Requirements for Electrical Systems” apply to this Section.

1.2 SUMMARY

A. Description: This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire detection equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP) modification, auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

B. Section Includes:

1. Addressable fire-alarm system.
2. Fire-alarm control unit (FACP).
3. Manual fire-alarm boxes.
4. Smoke detectors.
5. Heat detectors
6. Carbon monoxide detectors.
7. Fire-alarm notification appliances.
8. Fire-alarm graphic annunciators.
9. Fire-alarm remote annunciators.
10. Fire-alarm addressable interface devices.
11. Digital alarm communicator transmitters (DACTs).

1.3 REFERENCES

A. Abbreviations and Acronyms

1. DACT: Digital alarm communicator transmitter.
2. FACU (FACP): Fire-alarm control unit.
3. NICET: National Institute for Certification in Engineering Technologies.
4. NRTL: Nationally Recognized Testing Laboratory.

B. Definitions

1. Circuit: Wire path from a group of devices or appliances to a control panel or transponder.
2. Zone: Combination of one or more circuits or devices in a defined building area

1.4 COORDINATION

A. Testing existing system: Provide a complete functional test of the existing fire alarm systems prior to commencement of work. Report any non-functioning equipment or devices to Engineer. After commencing work, Contractor shall be responsible for ensuring all existing portions of the fire alarm system are properly functioning.

B. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from building.

C. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

D. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Engineer and Owner no fewer than 10 days in advance of proposed interruption of fire-alarm service.
2. Identify specific locations affected by interruption, circuits which may be inoperable during the outage, and the length of time the system will be impaired.
3. Do not proceed with interruption of fire-alarm service without the Owner's written permission.

E. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.5 SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: Submit for each type of product, including furnished options and accessories.

C. Shop Drawings: Provide for the fire alarm system.

1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, and details, including details of attachments to other Work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Annunciator panel details.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide control wiring diagrams for fire-alarm interface to HVAC and other building systems.
12. Coordinate location of duct smoke detectors and access to them.

a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
b. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
c. Locate detectors in accordance with manufacturer's written instructions.

13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

D. Delegated Design Submittals: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

E. Qualification Data: For Certified Installers, including names, license numbers, and certifications as described under Quality Assurance.

F. Sample Warranty.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01, include the following and deliver copies to authorities having jurisdiction:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

2. System Report: provide the engineer two bound copies of the following technical information, for transmittal to the owner:
a. As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment.
b. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing all interconnections in the system.
c. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
d. Manufacturer detailed maintenance requirement.

e. Technical literature on all control equipment, isolation modules, power supplies, batteries, detectors, manual stations, alarm/supervisory signal initiating devices, alarm notification appliances, relays, remote alarm transmission means, etc.
f. The as-built "calculations" sheet.

3. The contractor shall provide the owner with one copy of the following:
   a. All software required for the installed fire alarm system.
   b. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for system functions as described above.
   c. Framed floor plans mounted at the FACP: Plans shall show all system devices with the unique device identification numbers indicated adjacent to each device. The identification numbers shall match those represented in the as-built drawings and those reported at the FACP and the LCD annunciator. As-built room numbers shall match the signage in the building.
   d. Interconnection cable where such is required to connect the fire alarm system to a PC; (if Owner does not have the needed PC to check the system).
4. Electronic Archive: Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A USB drive or CD copy of this data shall be submitted to the engineer for transmission to the owner on the day the system is commissioned. A copy of this site-specific data base shall also be placed in the Documentation Cabinet. Provide copies of battery and voltage drop calculations at final inspection.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
4. Detector Bases: Quantity equal to 2 percent of amount installed, but no fewer than 1 unit.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: Two (2) of each type installed.
7. Fuses: Two of each type installed in the system.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. Manufacturer must be regularly engaged in manufacture of fire alarm systems of types, sizes, and electrical characteristics required, and whose products are Listed and Labeled.
2. Manufacturer shall maintain an authorized distributor within 100 miles of the project location which stocks a full complement of parts for all equipment to be furnished.

B. Installer Qualifications

1. Obtain certification by NRTL in accordance with NFPA 72.
2. Licensed or certified by authorities having jurisdiction to perform fire alarm installations in the specified jurisdiction.
3. Be in business a minimum of 5 continuous years with documented experience installing fire alarm systems similar in size in scope.
4. Installer must be responsible for all program changes and must be present for the 100% test, Designer’s pre-final review and Owner inspections.

5. All connections to the FACP and the system's programming shall be done only by the manufacturer, or by an authorized distributor.

C. Project Personnel Requirements: Installer must have the following certified full-time employees on staff and assigned to the project.

1. All personnel must be trained and certified by manufacturer for installation of units required for this Project.
2. Project Engineer: Preparation of shop drawings, cabling administration drawings, and field-testing program development by a NICET certified Level IV technician who shall be trained and certified in fire alarm system design by the approved manufacturer within the last 36 months and be licensed by the authorities having jurisdiction.
3. Lead Technician: Minimum NICET certified Level III technician who shall provide all devices, connections, and programming for the fire alarm system. Technician shall be certified by the approved manufacturer within the last 36 months and licensed by the authorities having jurisdiction. The lead technician shall be present at all times when work of this Section is performed at the project site.
4. Installer Qualifications: Any work related to this section shall be by personnel trained and certified by the approved manufacturer within the last 24 months.

D. NFPA Certification: All devices used as part of the Fire Alarm System shall be listed under the appropriate category according to NFPA 72 by an NRTL.

1.8 WARRANTIES

A. Manufacturer Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship for a period of five years from date of Final acceptance.

B. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within 100 miles from the job site.

C. The manufacturer, or authorized distributor, must maintain software version (VER) records on the system installed. The system software shall be upgraded free of any charge if a new VER is released during the warranty period. For new VER to correct operating problems, free upgrade shall apply during the entire life of the system.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to the authority having jurisdiction, and marked for intended location and application.

B. All components provided shall be listed for use with the selected system.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Simplex by JCI
2. Edwards EST

3. Notifier
4. Siemens by Distribution Channel Only
5. Gamewell
6. **Potter**

B. Being listed as an acceptable Manufacturer in no way relieves obligation of the Contractor to provide all equipment and features in accordance with these specifications.

C. Source Limitations for Fire-Alarm System and Components: Provide system manufacturer's certification that components provided have been tested as, and will operate as, a fully functional system.

2.3 ADDRESSABLE FIRE ALARM SYSTEM

A. Noncoded, UL-certified, FM Global-approved addressable system, with multiplexed signal transmission and capable of voice/strobe and horn/strobe evacuation.

2.4 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Automatic sprinkler system water flow.

B. Fire-alarm signal must initiate the following actions:

1. Continuously operate alarm notification appliances, including voice evacuation notices.
2. Identify alarm and specific initiating device at fire-alarm control unit and any remote annunciators or network connected control panels. The system alarm LED shall flash and a local piezo-electric signal in the control panel shall sound.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch HVAC equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Recall elevators to primary or alternate recall floors.
10. Activate elevator power shunt trip.
11. Activate emergency shutoffs for gas and fuel supplies, except for shutoffs serving legally required life-safety systems such as emergency generators.
12. Record events in system memory.
13. Record events by system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Elevator shunt-trip supervision.
3. Duct smoke detectors.
4. Carbon Monoxide detectors.
5. Fire pump is running.
6. Fire pump has lost power.
7. Power to fire pump has phase reversal.
8. Zones or individual devices have been disabled.

9. Loss of communication with any panel on the network.

D. System Supervisory Signal Actions:

1. Identify specific device initiating the event at fire-alarm control unit and remote annunciators. The corresponding system LED shall flash and a local piezo-electric signal in the control panel shall sound.
2. Record the event on system printer.
3. Transmit a supervisory signal to the remote alarm receiving station with no time delay.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in circuits.
2. Opening, tampering with, or removing alarm-initiating device, alarm appliance, plug-in relay, system module, battery connection, and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Smoke Detector Contamination.

F. System Trouble Signal Actions:

1. Identify specific device initiating the event at fire-alarm control unit and remote annunciators. The system trouble LED shall flash and a local piezo-electric signal in the control panel shall sound.
2. Record the event on system printer.
3. Transmit a trouble to the remote alarm receiving station after a programmable time delay of 200 seconds.
4. A trouble signal from loss of primary power shall not be transmitted unless maintained after a programmable time delay of 1 to 3 hours.
5. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

2.5 FIRE ALARM CONTROL PANEL (FACP)

A. General Requirements for Fire Alarm Control Panel:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 category UUKL for protection of the CPU and its associated equipment from voltage surges or line transients.

   a. System software and all control-by-event programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer. Time-of-Day and date shall be retained through failure of primary and secondary power supplies.
   c. The Central Processing Unit (CPU) shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.

d. Provide communication between the FACP and intelligent detectors, addressable modules, local and remote operator terminals, remote circuit interface panels, annunciators, and other system-controlled devices.
e. The FACP shall be listed for connection to a central-station signaling system service.
f. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
g. The system is to have multiple access levels, so owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. The process on how to do this must be included in the training required to be given to the owner's designated personnel and must also be part of the written documentation provided by the fire alarm equipment supplier. A minimum of two different password levels shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
h. System shall supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
i. Supervise all initiating, signaling, and notification circuits throughout the facility by way of connection to monitor and control modules, or end of line resistor.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
4. The system shall perform time-based control functions including automatic changes of specified smoke detector sensitivity settings.
5. Digitized electronic signals shall employ check digits or multiple polling. In general, a single ground or open on any system signaling line circuit shall not cause system malfunction, loss of operating power, or the ability to report an alarm.
6. Loss of Power: 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.
7. The FACP must have an Alarm Silence switch and be equipped with the Subsequent Alarm (alarm resound) feature. Any remote annunciators or graphic displays located away from the alarm area must also include an audible signal with alarm resound feature.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Alphanumeric Touch Keypad: Arranged to permit entry and execution of programming, display, and control commands.
3. Four color coded system status LEDs to indicate status of the following system parameters:
   a. AC Power
   b. System Alarm
   c. System Trouble
   d. Signal Silence
4. Provide operator’s interface which allows the following minimum functions. In addition, the operator’s interface shall support any other functions required for system control and/or operation:
   a. Acknowledge (ACK/STEP) Switch
   b. Signal Silence Switch
   c. System Reset Switch
   d. System Test Switch
   e. Lamp Test Switch

f. Programmable, supervised switches for fire safety function bypasses. i.e. NAC Bypass, Elevator Capture Bypass, HVAC Shutdown Defeat, Smoke Control Bypass, etc. Switch operation shall be password protected.
g. Interface shall allow programming of the system without any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

C. Signaling Line Circuit (SLC) Interface Board: The FACP shall contain SLC interface boards as required to communicate with the SLC. Each SLC board shall monitor and control a minimum of 198 intelligent addressable devices. This includes 99 analog detectors (Ionization, Photoelectric, or Thermal) and 99 monitor or control modules.

1. Each SLC interface board shall contain its own microprocessor and shall be capable of operating in a local mode (any SLC input activates all or specific SLC outputs) in the event of a failure in the main CPU of the control panel. The SLC interface board shall not require any jumper cuts or address switch settings to initialize SLC Loop operations. SLC interface boards shall provide power and communicate with all intelligent addressable detectors and modules connected to its SLC Loop on a single pair of wires. This SLC Loop shall be capable of operation as NFPA 72 Class A (Style 6) or Class X (Style 7).
2. Each SLC interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that specific detector. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Signaling Line Circuits (SLC): NFPA, Class B..
   a. Provide a minimum of one signaling line circuit per floor.
2. Initiating Device Circuits (IDC): NFPA 72, Class B.
3. Notification Appliance Circuits (NAC): NFPA 72, Class B.
4. Network Circuit Between Addressable Panels: NFPA 72, Class A.
5. System shall be capable accommodating up to 198 addressable devices on each signaling-line circuit (SLC) and a minimum of 1980 initiating points per system.
6. Each signaling line circuit and notification appliance circuit shall be sized to allow a minimum additional capacity of 20%.
7. Serial Interfaces:
   a. One dedicated RS 485 port for central-station operation using point ID DACT.
   b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
   c. One USB port for on-site programming or system modification with a PC.
   d. One RS 232 port for voice evacuation interface.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.

2. Where notification appliances provide signals to sleeping or dwelling areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment and Testing: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. The control panel shall provide a display and a printed list of these sensitivity measurements as a permanent record of the required sensitivity testing. The system shall also annunciate a trouble condition when any smoke detector approaches 80% of its alarm threshold due to gradual contamination, with an annunciation of the location of the smoke detector requiring service. If any specialized equipment must be used to program any function of the smoke detector devices, then one must be furnished as part of the system.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station in accordance with parameters specified herein.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control panel.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

    a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.
    c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

L. Primary Power: Obtained from dedicated 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Power supply modules shall have a continuous rating adequate to power all equipment and functions in full alarm continuously. All modules and drivers must be able to withstand prolonged short

circuits in the field wiring, either line-to-line or line-to-ground, without damage. Further, the power supply shall be expandable for additional notification appliance power in 3.0 Ampere increments.

2. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
3. Primary power source shall be identified FIRE ALARM SYSTEM with a red and white engraved plastic sign permanently affixed to the face of the switch. Install lock clips on circuit breakers in the "ON" position.

M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

1. Batteries: Maintenance-free, rechargeable, sealed, gel cell with rated lifespan of 10 years.
2. Provide sufficient capacity to operate the complete alarm system in normal, supervisory, or trouble conditions, including audible trouble signal devices, mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 15 minutes. Battery capacity must include a 25% safety factor.
3. Locate batteries either within the control panel or in a separate substantial steel cabinet, finished on inside and outside with enamel paint. Provide a non-corrosive base and cylinder lock keyed to match FACP. Separate cells to prevent contact between terminals of adjacent cells and between terminals and other metal parts. If providing separate battery cabinet, identify as FIRE ALARM SYSTEM BATTERY CABINET with a red and white engraved plastic sign permanently affixed to the face of the panel.
4. Battery Charger: Provide solid state automatic float type, capable of dual rate charging techniques for fast battery recharge. Locate charger within the control panel or within the battery cabinet. Provide voltmeter and ammeter to indicate battery voltage and charging current.

N. Enclosure: The FACP shall be housed in a 3rd party listed cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be hinged on either the right or left side (field selectable).

O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

P. The fire alarm control panel shall be provided with the following additional features:

1. Upload/Download to PC computer
2. Charger Rate Control
3. Drift Compensation
4. Automatic Day/Night Sensitivity Adjust
5. Device Blink Control
6. Pre-Alarm Control Panel Indication
7. Trouble Reminder
8. NFPA 72 Smoke Detector Sensitivity Test
9. System Status Reports
10. Periodic Detector Test
11. Alarm Verification, by device, with tally
12. Non-Alarm Module Reporting
13. Block Acknowledge
14. Smoke Detector Maintenance Alert
15. Control by Time

2.6 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type with visual indication operation; with screw terminals and integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit. When the station is operated, the handle shall lock in a manner showing visual indication of operation.
2. Station Test/Reset: Key-operated test/reset switch. Stations shall be keyed alike with the fire alarm control panel.
3. Manual pull stations that initiate an alarm condition when opening the unit are not acceptable.
4. Indoor Protective Shield: Where indicated on drawings, provide factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Where indicated on drawings, provide factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.7 SYSTEM SMOKE AND HEAT DETECTORS

A. General Requirements for System Detectors:

1. Comply with UL 268 7th edition for smoke detectors
2. Comply with UL 521 for heat detectors
3. Operating at 24-V dc, nominal.
4. Detectors shall be minimum two-wire type.
5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit through a signaling line circuit (SLC). Provide an address-setting means.
6. Device Identification: Detectors shall store an internal identifying type code that the control panel shall use to identify the type of device.
7. Base Mounting: Detector and associated electronic components shall be ceiling mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring. The base shall have integral terminal strips for circuit connections, rather than wire pigtails.
8. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
9. Integral Visual-Indicating Light: dual LED type. LEDs shall flash under normal conditions, indicating that the device is operational and in regular communication with the control panel. The flashing mode operation of the detector LEDs shall be optional through the system field program.
10. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

    a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
    b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
    c. Multiple levels of detection sensitivity for each sensor.
    d. Sensitivity levels based on time of day.
    e. Compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors.

11. Test Means: 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 when in the "test" condition. Actual or synthetic smoke must be used during the 100% testing to assure smoke entry into the sensing chamber.

B. Photoelectric Smoke Detectors:

1. Photoelectric smoke 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.
2. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
3. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. Ionization smoke detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
2. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
3. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

E. Heat Detectors

1. Heat detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.
2. Temperature sensors shall test for and communicate the sensitivity range of the device.
3. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
4. Heat Detector, Fixed-Temperature Type: Used in elevator machine rooms or hoist ways, select temperature rating nominal 10 degrees F less than the adjacent fire sprinkler.

F. Multicriteria Detectors

1. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.
2. The outputs of the analog sensors shall be transformed into digital signals that are combined and processed by special algorithms. The computations shall be designed to discriminate between normal ambient changes in a building and those changes associated with a fire.
3. Test button tests all sensors in the detector.
4. Provide photoelectric smoke detection, ionization smoke detection and rate of rise thermal detection.

2.8 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.9 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as noted, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Devices located in a damp or wet location shall be listed for environment.

C. Devices located in sleeping areas shall produce a low frequency alarm signal that has a fundamental frequency of 520Hz +- 10% and shall be a square wave or provide equivalent awakening ability.

D. Audible/Visual Combination Devices shall comply with all applicable requirements for both Speaker Voice/Tone Notification and Visible Notification Appliances.

E. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:15/30/75/110 cd, selectable from the fire alarm control unit or in the field.
2. Voltage: 24VDC nominal
3. Mounting: Wall mounted to standard electrical box unless otherwise indicated.
4. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
5. Flashing shall be in a temporal pattern, synchronized with other units. Maximum pulse duration: 2/10ths of one second.
6. Strobe Leads: Factory connected to screw terminals.
7. Mounting Faceplate: Factory finished, red.

F. Speaker Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. Speaker Operating Voltage: 25V or 70V.
4. Mounting: Flush onto standard 4” square backbox.
5. Rated sound pressure level of 84dBA at 10 feet for 1-watt tap.
6. Matching Transformers: Tap range at 1/4-watt, 1/2-watt, 1-watt, and 2-watt. Speakers shall be tapped at 1 watt for design purposes.
7. Devices located in sleeping rooms shall be listed to produce high fidelity 520Hz low frequency output in accordance with UL464 and NFPA 72 requirements.

G. Bell: vibrating type with 10” gong
1. Voltage: 24VDC
2. Mounting: Surface or Semi-flush on a standard 4” square electrical box
3. Suitable for wet locations

2.10 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate. The door portion shall have a plated steel pivot mounted armature with shock absorbing nylon bearing.

1. Electromagnets: Require no more than 1 W to develop 35-lbf holding force.
2. Wall-Mounted Units: Flush mounted in a single gang electrical box unless otherwise indicated.
3. Rating: 24-V dc operating on power from the fire alarm control panel.
4. Power source shall be supervised.
5. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings.

B. Material and Finish: Match door hardware.

C. Operation: Under normal conditions, the magnets shall attract and hold the door open. Upon activation of the building fire alarm system, the devices shall be de-energized, thus releasing the doors on the circuit.

2.11 REMOTE ANNUNCIATOR

A. Description: Annunciator and messaging functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.
2. Annunciator shall communicate with the fire alarm control panel via an EIA-485 communications loop (four-wire) and shall individually annunciate all zones in the system. System zones shall be as indicated on the Drawings. Up to 10 annunciators may be connected to the EIA-485 communications loop.

B. Annunciator Indicators: The annunciator shall provide a red Alarm LED per zone, and a yellow Trouble LED per zone. The annunciator shall also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels. Annunciator switches may be used for System control such as, Global Acknowledge, Global Signal Silence, and Global System Reset. All annunciator switches and indicators shall be software programmable.

C. LCD Alphanumeric Display Annunciator: The Alphanumeric Display Annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text. The LCD Annunciator shall display all alarms and trouble conditions in the system.

D. System Capacity: The system shall allow a minimum of four LCD annunciators. In addition to annunciation functions, each LCD annunciator shall be capable of the following software programmed system functions: Acknowledge, Signal Silence and Reset.

E. Connections: The annunciator shall connect to a two-wire EIA-485 interface. The two-wire connection shall be capable operation at distances of 6,000 feet. Provide interface to fiber optic cable systems and/or repeater units where such are indicated on the Drawings.

2.12 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications. Addressable Monitor Modules shall be provided to connect one supervised zone (either Style D or Style B) of non-addressable Alarm Initiating Devices (any Normally Open [N.O.] dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings.
1. Indication of 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.
2. Supervision: Unless specifically noted otherwise on the drawings provide one monitor module for each sprinkler switch.

C. Addressable Control Module: Addressable Control Modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized Audio/Visual (A/V) Notification Appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay. The control module shall provide address-setting means. An LED shall be provided that shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel. If the voltage being controlled is 120 VAC or greater, an isolating 24 VDC relay shall be used.
1. Configuration: The control module NAC circuit may be wired for 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 (Form C) relay. The control module shall be suitable for pilot duty applications and rated for a minimum of

0.6 amps at 30 VDC. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires. Designer shall confirm the relay contacts are rated for the attached load.

2. Power Source: Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, 3rd party listed remote power supply. A/V power sources and connections are not shown on the Drawings.

2.13 DACT/CELLULAR COMMUNICATOR TRANSMITTERS

A. Digital alarm communicator transmitter and cellular communicator shall be acceptable to the remote central station and shall comply with UL 864.
   1. DACT: Minimum of 4-channels, dual transmission link type.
   2. Cellular Communicator: 3G with 2G fall back cellular connection through the cellular module. Provide antenna extension kits where required to ensure a high-quality connection.
   3. Primary Path: DACT with analog telephone line
   4. Secondary Path: Cellular Communicator

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture a telephone line and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If connecting by POTS and service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining transmission line. Transmitter shall automatically report transmission channel restoration to the central station. If service is lost on both transmission channels, transmitter shall initiate the local trouble signal.

C. The following signals shall be reported at a minimum:
   1. Fire Alarm
   2. Sprinkler Water Flow Alarm
   3. Fire Pump Running Alarm as a supervisory signal
   4. Fire Pump Abnormal Status Supervisory Signal
   5. Sprinkler Valve Tamper (Closed) Supervisory Signal
   6. Sprinkler Low Temperature / Air Pressure Supervisory Signal
   7. Fire Alarm System AC Power Trouble (only if 120vac interrupted for 1 to 8 hours)

D. The precedence of DACT / signals transmitted to the Supervising Station shall be as follows:
   1. Fire Alarm
   2. Water flow
   3. Supervisory Signal
   4. Trouble Signal

E. Local functions and display at the digital alarm communicator transmitter shall include the following:

   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   4. Manual test report function and manual transmission clear indication.
   5. Communications failure with the central station or fire-alarm control unit.

F. Secondary Power: Integral rechargeable battery and automatic charger.

G. Self-Test: Conducted automatically every 24 hours with report transmitted to central station. Constant connection supervision and detects failures within 90 seconds for Cellular connection.

2.14 MISCELLANEOUS DEVICES

A. Isolator Module: 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 to 20 addressable devices. Modules must be readily accessible (not above ceiling) and clearly labeled.
   1. Operation: Isolator Modules shall operate such that 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. The Isolator Module's operations shall be totally automatic.
   2. The Isolator Modules 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.

B. Water Flow Switch: Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type. Flow switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Flow switches shall be located a minimum of one (1) foot from a fitting that changes the direction of the flow and a minimum of three (3) feet from a valve as required per NFPA 13. Installation: Water Flow Switches shall be connected by the Division 16 (Electrical) Contractor but furnished and installed by the Division 23 (Mechanical) Contractor.

C. Sprinkler and Standpipe Valve Supervisory Switch: Supervisory switch mechanisms shall be contained in a weatherproof housing that shall provide a 3/4-inch tapped conduit entrance and shall incorporate the necessary facilities for attachment to the valves. Switch housing shall be finished in red baked enamel. Mounting: Mount switch so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

D. Remote Annunciator Indicator Lights (RAIL): RAILs shall be provided with a key type switch for testing of the annunciated device. In addition. RAILs shall have the following features: Voltage: RAILs shall operate on 24 VDC nominal.

2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection. Factory fabricated and furnished by device manufacturer with painted finish to match the protected device. Guards provided in locations as shown on plans.

2.16 SURGE PROTECTION

A. On AC Input: A feed-through (not shunt-type) branch circuit transient suppressor such as Leviton 51020-WM-DIN, or Ditek DTK-120SRD 20 Amp or equivalent UL 1449 - Latest Edition Listed device.

B. On DC Circuits Extending Outside Building: At a point near entry to the building provide "pi"-type filter on each leg, consisting of a primary arrestor, series impedance, and a fast-acting secondary arrestor that clamps at 30v-40v. Some acceptable models: Simplex 2081-9027, Simplex 2081-9028, Transtector TSP8601, Ditek DTK 2MHLP24BWB series, Citel America B280-24V, and Northern Technologies DLP-42. Submit data on others to the engineer for approval. UL 497B listing is normally a prerequisite for their consideration. Devices using only MOV active elements are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with the manufacture’s recommendations. The contractor shall consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

B. The technician who makes final connections and programs the FACP is the "installer" even though most field connections to system devices and appliances are normally made by electrical contractor personnel. The responsibility for assuring a proper installation overall rests with this individual fire alarm system technician. In addition to doing the final hookups and activating the system, this individual is expected to check the field connections to assure all work is properly done. The absence of system "trouble" signals is not an adequate measure of the field wiring, which could have "T" taps, the wrong type of wire, improper terminations, ground (drain wire) issues, etc.

C. Notification Appliance Circuit booster power supplies must be individually monitored by the FACP and protected by a smoke detector per NFPA 72. They shall not be located above a ceiling, or in non-conditioned space. A 24vdc power circuit serving addressable control relays must also be monitored for integrity. All fire alarm power supplies shall have 120-volts surge suppressors.

D. Basic operating instructions shall be framed and permanently mounted at the FACP. (If the owner concurs, they may instead be affixed to the inside of the FACP's door.) In addition, the NFPA 72 "Record of Completion" must either be kept at the FACP, or its location shall be permanently indicated there by an engraved label. All System documentation shall be provided and housed in a Documentation Cabinet at the control panel or other approved location. (Per 2013 NFPA 72: 7.7.2)

E. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

F. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

G. All system components 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. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.

H. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

I. Smoke- or Heat-Detectors:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than [36 inches (910 mm)] [60 inches (1520 mm)] from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
7. When installed in a room, detectors shall be oriented, so their alarm light is visible from the nearest door to the corridor, unless Remote Alarm Indicator Light (RAIL) equipped.
8. Spot-type smoke detectors shall secure the head to the base thru the built-in locking device. For detector mounted within 12 feet of the floor, activate this lock after the system has been inspected and given final acceptance.
9. Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be replaced by the contractor at no additional cost to the Owner. Covers supplied with smoke detector heads do not provide protection against heavy construction dust, spray painting, etc., and must not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.

J. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends. The preferred method for providing support is to extend the intake tube through the far side of the duct, seal around the tube where it penetrates the duct wall and plug the end with a rubber stopper. This facilitates visual inspection and intake tube cleaning.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to final acceptance.
2. All air duct/plenum detectors must have a Remote Alarm Indicator Lamp with test switch (RAILS) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Duct smoke detectors are permitted to be installed only inside an air duct. It is not appropriate to mount them in front of a return air opening. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration. The numbers of detectors per duct shall be per NFPA 72 requirements based on the size of the air duct, air duct configuration, air speed, and duct manufacture’s installation requirements.
3. Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector, using stencil or permanent decal.
4. Duct smoke detector mounting position and air sampling tube orientation, are critical for proper operation. The Manufacturer's detailed installation instructions must be followed. The contractor shall mark the direction of air flow on the duct at each duct detector location.

5. Avoid the use of duct detectors on outside air intakes, as this can lead to nuisance alarms and troubles from moisture and dust.
6. A fire alarm panel output for a duct detector signal shall be as required by NC Building Codes and NFPA 72.

K. Alarm Verification for Smoke Detectors: System shall provide as a feature an alternate signal processing algorithm to verify the presence of smoke. The algorithm shall be selectable during system programming. The total effective delay created by the verification algorithm shall not exceed 60 seconds. Do not activate alarm verification unless directed to do so by AHJ, Designer, or owner.

L. When programming the system, activate the automatic drift compensation feature for all spot type smoke detectors. Systems with alarm verification are not to have this feature activated without written direction from the owner's representative or the AHJ. Alarm verification must not be used with multi-sensor/multi-criteria detectors under any circumstances, as inadequate system response may result. Most applications of analog addressable smoke detectors do not require alarm verification to reduce nuisance alarms, as they are better able to discriminate between fire and common non-fire ambient events. A short operational test with normal occupancy can determine if transient ambient events are a problem.

M. Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the design engineer/owner's rep. High sensitivity may be appropriate in relatively benign, clean environments such as art museums and libraries, to improve system response time without causing nuisance alarms.

N. Print a complete System Status and Programming Report after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector. This documentation shall be provided at the inspection.

O. Addressable Interface Modules:
1. Addressable interface modules (used to monitor all contact type initiating devices) must be in a conditioned space, unless they are tested, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location.
2. One module may serve as many as 6 heat detectors, in a single space.
3. Sprinkler system supervisory circuits for monitoring valve position, air pressure, water temperature, pump status, etc., must cause distinct audible and visible indications at the FACP.

P. Air Handling Unit (AHU) Shutdown
1. A supervised "AHU Shutdown Defeat" switch must be provided in/adjacent to the FACP with an informative engraved label at the FACP about this function. The switch must cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position. This is to provide the owner with a convenient means to temporarily resume HVAC operation in the event an unwanted alarm will not clear, prior to arrival of the fire alarm service technician, or for testing purposes.
2. All shutdown relays must be directly controlled and monitored by the fire alarm system. The Building Automation System (BAS) shall not be used for life safety functions unless the BAS is supervised by the Fire Alarm System for off normal conditions. Relays should be wired fail safe.

Q. Shunt Trip Monitoring: The fire alarm system shall monitor 120-VAC power to shunt trip breakers used in conjunction with fire suppression systems. Use an addressable monitor module to accomplish this supervisory function. Provide a breaker handle lock-on device on circuits used for shunt trip power.

R. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

S. Audible and Visible Alarm-Indicating Devices:
1. Comply with NFPA 72, the State Building Code, and ANSI 117 criteria for intensity and placement. The standard audible evacuation signal is the ANSI S3.41 three-pulse temporal pattern.

2. Install wall devices with entire lens between 80-inches and 96-inches above the floor but not less than 6 inches below the ceiling. Install devices on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
3. The location of all end of line devices shall be labeled on the device, with NAC panel number and NAC circuit number, and recorded on the "As-built" drawings. EOL shall not be located more than 12-feet above finished floor.

T. Automatic Smoke Door and Automatic Electric Lock Interface:
1. Wall-mounted magnetic door holders and separate heavy-duty closers shall be used, instead of combination door control units. The electromagnets shall be controlled by the building's smoke detection system FACP. Individual smoke detector auxiliary contacts shall not be used to release door holders.
2. Door Holders: locate armature 6" down from top and 6" in from strike side of leaf. Where door swing prevents direct contact between armature and holder pole piece, provide plated chain to close gap as tightly as possible. Verify holder positioning with architect prior to mounting any devices.
3. Smoke doors are permitted to be held open by 24vdc wall/floor-mounted magnets powered by the FACP and released upon alarm. The resulting current drain shall be included in the standby battery calculations or the system must be programmed to drop the door hold-open magnet load within 60 seconds after loss of 120vac power.
4. Automatic door locks controlled by the system must be either fail safe magnetic locks or failsafe electro-mechanical with reverse bevel dead bolts.
5. All locked protected doors must immediately unlock upon fire alarm, loss of AC power, disablement of the fire alarm system (defined as loss of 24 VDC power) or upon manual operation of an unlock switch at a constantly attended location.
6. For life safety reasons, any exit or exit access doors that are locked to delay egress, in accordance with the NC Building Code, must utilize one of the following types of locking hardware:
    a. Magnetic Lock (fail-safe) utilizing a 24vdc magnet and contact plate
    b. Electro-Mechanical Lock (fail-safe) with reverse bevel type dead bolt
7. Where installed on smoke or fire doors, power failure shall cause these mechanisms to default to the egress mode with normal mechanical latching. This is to assure the smoke or fire doors continue to perform their vital function in a power failure situation, instead of swinging open and allowing the passage of smoke and fire between compartments.

U. Sprinkler System Interface:
1. The following sprinkler system alarm and supervisory functions shall be provided as a part of the fire alarm system:
    a. Water flow alarm, by sprinkler zone (not to exceed one floor).
    b. Supervision of each control valve.
    c. Supervision of air pressure, if used (both high and low).
    d. Supervision of fire pump.
    e. Hot Box low temperature.
    f. Elevator shunt trip power off. Provide breaker clip on circuit breaker used for elevator shunt trip power.
2. Sprinkler supervisory monitoring of flow switches, tamper switches, and similar functions shall be accomplished with a separate system address for each activity monitored.

V. Device Location-Indicating Lights: Locate in public space near the device they monitor.

W. Provide wire guards for all devices in areas where prone to physical damage such as gyms. Wireguards shall allow for proper clearance around devices.

X. Where the anticipated atmosphere or installation conditions require weather-proof, explosion-proof or other specially housed devices, they shall be U.L.-listed and NFPA-compliant and provided as indicated or required. Verify installation conditions and indicate type of device on shop drawing submission. Provide weather-proof device and backbox.

Y. Surge Protection:
   1. For each AC power circuit that interfaces with fire alarm equipment, install an AC suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the suppressor in clipping fast rise time voltage transients.
   2. On DC Circuits Extending Outside Building: Install the surge arrestor in a labeled enclosure near the point of entry to or exit from each building.

Z. Supervision required: The connection between individual addressable modules and their contact type initiating device(s) must be supervised.

AA. Alarm Transmission: Connect each DACT to the telephone lines, program, and verify proper signal receipt by the Supervising Station. The transmission means shall comply with NFPA 72.

3.3 PATHWAYS AND CONDUCTORS

A. All alarm and signal wiring shall be in accordance with the manufacturer's recommendations and installed in open cabling supports above an accessible ceiling or in an approved raceway specified in Division 26.

B. All junction boxes containing fire alarm conductors shall be colored with red enamel paint and manufactured to designate "Fire Alarm". All junction box covers shall be painted red on both sides. The interior of junction boxes shall not be painted.

C. All surface boxes shall be as manufactured by the device manufacturer for the installed device and shall match devices in size.

D. All conduits that penetrate outside walls from air-conditioned space must have internal sealing (duct-seal), to prevent condensation from infiltrating humid air.

E. All the circuits in the system shall be wired with 14 AWG, minimum, stranded copper, THHN/THWN conductor, installed in metallic conduits.

F. Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP, any 120 VAC control wiring or other circuits with an externally supplied AC/DC voltage above the nominal 24 VDC system power must be properly separated by a minimum of .25 inches per NEC, from other circuits, and the enclosure must have an appropriate warning label, to alert service personnel to the potential hazard. Reference NEC 760.136.

G. Systems with one or more addressable sub-panels that (1) have an integral addressable loop controller, or (2) monitor multiple non-addressable initiation zones, shall comply with the NFPA 72 requirements for Class "A" circuits for their networking cables.

H. There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will not be permitted. All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

I. All circuits leaving the riser on each floor shall feed through a labeled terminal block in a hinged enclosure accessible from the floor. If building layout requires the terminal cabinet to be above a drop ceiling, its location must be clearly and permanently identified with a placard readable from floor. Terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

J. Isolation Modules: To minimize wiring fault impact, isolation modules shall be provided in all the locations listed below.

1. In or immediately adjacent to the FACP, at each end of the addressable loop. These two isolators must be in the same room and within 15 feet of the FACP.
2. After each 20 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer.
3. For loops with less than 20 devices and control points, install an isolator at the approximate middle of the loop (in addition to those at the FACP).
4. Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.
5. For loops covering more than one floor, install isolator at terminal cabinet on each floor (with additional isolator[s] on any floor with over 20 addresses).
6. Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built drawings

K. All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be ten (10) megohms, as verified with an insulation tester. Provide advanced notice to the Engineer of record of these tests.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Coordinate connections to electronic access-controlled doors with door hardware specifications and actual door hardware. Provide all connections for release of locking mechanisms in egress paths as required.

C. Verify exact connection requirements to all equipment and devices of other trades with those trades prior to ordering equipment.

D. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors.
4. Alarm-initiating connection to elevator recall system and components.
5. Supervisory connections at each valve supervisory switches.
6. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
7. Supervisory connections at elevator shunt-trip breaker.
8. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
9. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

A. Identify all system components, wiring, cabling, and terminals.

B. Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained therein. Labels shall be neatly applied black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

C. All fire alarm wiring shall be color coded to match existing color scheme, which shall be maintained throughout the system, without any color changes in the wire:

D. Permanent wire markers shall be used to identify all connections at the FACP and other control equipment, at power supplies, and in terminal cabinets.

E. Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACP: (Addressable Loop # -- Device #) Show on the as-built plans, and permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing. Device labels may not be affixed to the device. Identification labels must be printed labels with black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

F. Loop 1 shall be assigned to the lowest level devices and loop number shall increase with floor number. Device numbering starts in the same location on each floor and increase accordingly as circuit location increases.

G. Install framed instructions in a location visible from fire-alarm control unit.

H. Floor Plans with Device Numbers: A copy of the floor plans shall be provided in the Documentation Cabinet at the control panel. A separate sheet shall be provided for each floor. Plans shall be reduced in size from engineering plans in order to fit on 11 x 14 sheets. All device addresses shall be clearly labeled on plans. Indicate locations of all cabinets, modules and end of line device.

I. Provide an engraved label on outside of the FACP door identifying its 120-vac power source, as follows: Panelboard location, panelboard identification, and branch circuit number. On inside of FACP door, indicate panelboard location.

J. Provide an engraved label at each fire alarm system control unit, system sub-panel or data gathering panel, supplementary notification appliance (NAC) panel, digital alarm communicator, etc. identifying the panel location, panel name, and breaker number for the 120VAC circuit.

K. The branch circuit breaker(s) supplying 120VAC power to the system must be physically protected by a breaker handle lock-on device and each must be identified with a 1/4" permanent red dot applied to handle or exposed body area.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Upon completion of the installation the Contractor and the Manufacturer's authorized installer and designer together shall conduct a 100% performance test of every alarm initiating device for proper response. The system shall operate for 48 hours prior to start of test. The Contractor shall be present for the full 100% test. The person responsible for programming the system must be present.

B. Provide written notice to all concerned parties 7-days prior to testing. All Audio-Visual Device Testing shall be scheduled with the owner.

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Joint-sealant backer materials.
3. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of joint sealant and accessory.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.

B. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Meadows, W.R., Inc.; Pourthane NS.

C. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Meadows, W.R., Inc.; Pourthane SL.

D. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; Dynatred.

2.3 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

2.4 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 323113 - ARCHITECTURAL SCREENING AND GATES

PART 1 – GENERAL

1.1. DESCRIPTION

A. This section describes the following fence system:

1. Solid panels fabricated with PlyGem Woodland Select series tongue and groove planks and structural aluminum profiles including extruded aluminum fence posts and aluminum panel gates. Solid panel security screening and gates shall be furnished and installed as shown on the plans and specified herein, overall height of solid screening shall be 6'-0" tall.

1.2. REQUIREMENTS

A. Furnish materials, labor, expertise and equipment necessary to complete all work specified in this section and as shown on the drawings.

B. Structural Performance: Provide product and installation capable of withstanding the effects of gravity lads and the following loads and stresses within limits and under conditions indicated.

1. Uniform pressure of 30 lbf/sq. ft. acting inward or outward.
2. Thermal Movements resulting from a temperature change (range) of 120 degrees Fahrenheit ambient and 180 degrees Fahrenheit material surfaces.

1.3. SUBMITTALS

A. Shop drawings and manufacturer's literature: Provide specifications and construction detail drawings to substantiate quality of materials and provide details of fabrication and installation.

B. Submittals shall be in accordance with standard construction practices to include complete detailed layout of all panels, posts, gates. Submittals shall include plan layout, elevations and section views of panels, posts and gates.

C. Certificate: manufacturer's certification that materials meet specification requirements.

1.4. REFERENCES

A. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Ally Extruded Bars, Rods, Wire, Profiles and Tubes.

C. ASTM D3363 – Standard Test Method for Film Hardness by Pencil Test.

D. ASTM D2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation.

E. ASTM B117 – Standard Practice for Operating Salt Spray Apparatus.

F. ASTM D822 – Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of

Paint and Related Coatings.

G. AWS D1.2 Structural Welding Code – Aluminum.

H. American Society for Testing and Materials (ASTM):

I. ASTM D256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

J. ASTM D638 Standard Test Method for Tensile Properties of Plastics.

K. ASTM D648 Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.

L. ASTM D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

M. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

N. ASTM D4216 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) and Related PVC and Chlorinated Poly (Vinyl Chloride) (CPVC) Building Products Compounds.

O. ASTM F964 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Exterior Profiles Used for Fencing.

1.5. QUALITY ASSURANCE

A. Installation of fence and materials shall conform to the requirements of the fence manufacturer.

B. The fence shall be warranted from any defects in materials and workmanship for a period as specified in the relevant section of the contract documents.

PART 2 – PRODUCTS

2.1. MATERIALS

A. Solid panel security fence:

1. Approved Architectural Solid Screening System, Manufacturer:

a. PalmSHIELD Manufacturing

2. Material Descriptions:

a. Extruded Aluminum: ASTM B 221, Alloy 6063 – Temper T-6.
b. Sheet Aluminum: ASTM B211, Alloy 6063 – Temper T6.
c. Powder Coating Material Hardness: ASTM 3363 2H.

2. Panel Description:

   a. Panel Height: 6'-0"
   b. Panel Width: Not to exceed 60"
   c. Solid panel system consisting of horizontal tongue and groove modular panels fabricated with extruded aluminum framing structural profiles and supported by extruded aluminum fence posts.
   d. 7/8" x 6" (22.2 x 152 mm) tongue & groove (T&G) polyvinyl chloride plank.
   e. White, tan, sandstone, or khaki. Natural Cedar (1" x 8" T&G only), Weathered Cedar (1" x 8" T&G only) and Redwood (1" x 8" T&G only),
   f. Panel Vertical Framework: 2 ½" x 2 ½" x 1/8" inch aluminum angle. Framework supporting the solid tongue and groove screening shall be solid welded and mitered.
   g. Panel Horizontal Top Cap: 2 ½" x 2 ½" x 1/8" inch aluminum angle
   h. Panel Horizontal Bottom Cap: 2 ½" x 2 ½" x 1/8" inch aluminum angle

3. Fence Posts:

   a. Panel posts shall be 3" square x 1/8" inch minimum extruded tubular aluminum sections with solid aluminum caps. Length as specified on the contract drawings.
   b. On center post spacing shall be as specified by manufacturer.
   c. All fence posts to be plated with 8" x 8" x5 /8" aluminum plates with four ¾" hole for anchors.

4. Fittings and accessories: All fittings and accessories shall be stainless steel and sized as specified by the fence manufacturer. Fence panels to be attached to posts with ¼" x 1" stainless steel screws. Panels and posts are predrilled to support level installation.

5. Anchor Bolts: Anchor bolts shall be anchored to concrete slab and adequate to support loads based on screening height, exposures and loading.

6. Gates: Swing to exterior of enclosure, size as shown on contract drawings.

   a. Panel spacing, style and appearance shall be identical to fence panels.
   b. Gate hinges to be Gorilla barrel hinge with ¾" rod, ball bearing, and grease zert. Hinge plate to be ½" thick plates offset to create a 5/8" gap. Standard hardware as required by the gate manufacturer for complete functional operation. Hinges to be bolted to gate frame and field welded to steel gate posts.
   c. Gate latch to be internal lock with exterior grab handles. Lock may be keyed and rekeyed. Lock is accessible from both sides of gate.
   d. Welded frame, size as shown on the contract drawings, extruded aluminum tubing with aluminum fixed panels to match fencing material.
   e. Drop rods to be 1" schedule 40 pipe and through bolted to gate frame.
   f. Hardware: Size and type as determined by the manufacturer. Provide three hinges per leaf.

      1. Provide 1 inch diameter center cane bolt assembly and strike, each door.
      2. Provide padlockable slide bolt assembly.

   g. Gate shall have welded frame fabricated from extruded aluminum tubing with aluminum panels to match fencing material. Frame configurations shall be as indicated on the contract drawings.
   h. Gate posts shall be as determined by manufacture. Gate posts to be specified to support gates.

7. Factory Finish: Vinyl fence planks and aluminum posts and gates shall receive polyester powder coating.

   a. Polyester powder coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.
   b. Color shall be as selected by Owner.
   c. Minimum hardness measured in accordance with ASTM D3363 2H.
   d. Direct impact resistance tested in accordance with ASTM D2794. Withstand 160 inch-pounds.
   e. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95° F and 95% relative humidity after 1,000 hours, less than 3/16 inches undercutting.
   f. Weatherability tested in accordance with ASTM D822: No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted 45°.

PART 3 – EXECUTION

3.1 INSPECTION

A. Verify that final grading in fence location is completed and without irregularities which will interfere with fence installation. PalmShield is designed to be installed on a level surface. Variations in height, slopes, stairs steeping shall be shown on contract drawings and on submittal drawings.

B. Field verify all fence dimensions and layout prior to commencing installation.

C. Do not commence work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fence in accordance with manufacturer's installation instructions.

B. Install fence plumb and level. Posts are plated and mounted to top of surface.

C. Do not install bent, bowed or otherwise damaged panels. Remove damaged components from site and replace.

D. Secure fence panels with stainless with ¼" x 1" stainless steel screws to fence posts. All posts and panels will be predrilled to support level installation.

E. Gates

   a. Install gates and adjust hardware for smooth operation

END OF SECTION 321113

SECTION 329200 – LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding for non-athletic areas.
2. Lawn renovation.
3. Erosion-control material(s).
4. Fertilizer
5. Lime and mulch.
6. Maintenance until acceptance.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

F. Excess soils: Any soil materials that are not required to complete the Work.

G. Unsuitable Soils: Any soil material or deleterious materials that does not meet the requirements for subsoil or top soil, as determined by the Owner’s testing agency, Architect or Owner.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For soil amendments and fertilizers, from manufacturer.

E. Material Test Reports: For existing native surface topsoil, existing in-place surface soil and imported or manufactured topsoil.

F. Maintenance Instructions: Recommended procedures for maintenance of turf during the calendar year. Submit before expiration of required initial maintenance periods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful lawn and athletic turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in athletic turf installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor and personnel assigned to the Work shall have certification in all of the following categories from the Professional Landcare Network:

    a. Certified Landscape Technician - Exterior, with installation, maintenance and irrigation specialty area(s), designated CLT-Exterior.
    b. Certified Turfgrass Professional, designated CTP.
    c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
6. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1. Stating percentages or organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant nutrient content of topsoil.
2. Report suitability of topsoil for lawn and athletic field seed germination and growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and any limestone, aluminum sulfate, or other soil amendments to be added to produce a satisfactory topsoil.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of four representative samples shall be taken from each athletic field location and four additional test samples from lawn areas for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.

    a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Preinstallation Conference: Conduct conference at Project site.

1. Invite representative from lawn and athletic seed supplier to discuss specific requirements for proper installation and maintenance of newly seeded lawn and athletic field areas.
2. Review irrigation system operation and control.
3. Review soils testing agency report and recommendations for soil amendments and fertilizer.
4. Review procedures for final grading and preparation of sub grade areas.
5. Review procedures for final grading of top / surface soils, including the grading and removal of stones or other deleterious materials 1” or larger.
6. Review timing and procedures for seeding and methods for maintenance of seeded areas. Provide specific details on methods of irrigation and personnel available on a daily or weekly basis to carry out on-going maintenance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Fall Planting.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 MAINTENANCE SERVICE

A. Initial Lawn Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: Minimum 60 days after date of Contract Completion.

a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
b. Irrigate new seeded areas with 1" of water per day for 3 days. Continue with ¼" of water twice a day (early morning and early evening) until turf is fully established.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources or utilize irrigations system to keep lawn uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed.

D. Mow lawn as soon as top growth is 2-1/2" tall. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until glass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass to 2-1/2 inch high, remove clippings.

E. Lawn postfertilization:

1. Use starter fertilizer over the entire field (18-24-12 or equal) at a rate of 300 lbs. per field.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Full Sun (Non-Athletic Field Areas): Kentucky Bluegrass (Poa pratensis), a minimum of three cultivars.

C. Shade (Non-Athletic Field Areas): Proportioned by weight as follows:

a. 50 percent chewings red fescue (Festuca Rubra variety).
b. 35 percent rough bluegrass (Poa Trivialis).
c. 15 percent redtop (Agrostis Alba).

2.2 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials, including weeds, harmful to plant growth, unless otherwise noted. At competition athletic and planting beds, provide materials free of stones ½ inch or larger.

1. Topsoil Source (Disturbed Areas): Amend the existing top soil / surface soil stockpiled on-site as recommended by Soils Testing Agent. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, weeds, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

    a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
    b. Remove all deleterious materials from top soils and dispose of legally off of Owner's site.

2. Topsoil Source (Undisturbed): Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, weeds, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

    a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
    b. Remove all deleterious materials from top soils and dispose of legally off of Owner's site.

2.3 INORGANIC SOIL AMENDMENTS

A. Comply with Soils Testing Agency report and provide soil amendments as recommended.

B. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Lime (if required as a result of tests made under preceding Part 1): Shall be ground limestone (Dolomite) containing not less than 85 percent of total carbonates and shall be ground to such a fineness that 50 percent will pass through a 100 mesh sieve and 90 percent will pass through a 20 mesh sieve. Coarser material will be acceptable, provided the specified rates of application are increased proportionately on the basis of quantities passing the 100 mesh sieve.
2. Provide lime in form of dolomitic limestone.

C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.

2.4 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.5 FERTILIZER

A. Fertilizer: Commercial fertilizer shall be used for initial preparation and shall conform to the applicable state fertilizer laws. Use of organic lawn fertilizer shall be used for surface application after grass is up. Fertilizer shall be uniform in composition, dry and free flowing, and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Any fertilizer, which becomes caked or otherwise damaged, making it unwise damaged, making it unsuitable for use, will not be acceptable. Commercial-grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen, 50 percent derived from natural organic sources of area formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.6 MULCHES

A. Wood Cellulose Fiber Mulch: Shall not contain any growth or germination – inhibiting factors and shall be dyed an appropriate color to facilitate placement during application. Composition on air=dry weight basis: 9 to 15 percent moisture pH from 4.5 to 1.0.

1. Application: 70% of mulch mixture.

B. Paper Fiber Mulch: Shall be recycled newsprint that is shredded for the purpose of mulching seed.

1. Application: 30% of mulch mixture.

(Where irrigation is not available)

C. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

D. Asphalt Emulsion: ASTM D 977, Grade Ss-1; nontoxic and free of plant-growth or germination inhibitors.

2.7 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN AND TOP SOILS PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Excavate and remove non-surface soils or unsuitable soils to a minimum depth required to accommodate the amended top / surface soils. Remove unsuitable or excess soils and legally dispose of off Owners property.

C. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply superphosphate fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil mix to a depth of 6 inches (100 mm) but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately 1/2 the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil mix.

D. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches (150 mm). Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches (100 mm) of soil. Till soil to a homogeneous mixture of fine texture.

    a. Apply superphosphate fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
1. Once finish grading is completed and prior to commencing seeding, notify A/E and Construction Manager. Do not proceed until completed work is observed and authorized.

F. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

G. Before planting, restore areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Do not proceed with seeding until finish grading is completed and commencement of seeding is authorized by Construction Manager and A/E.

B. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

C. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft., or greater rates if recommended by seed manufacturer.

D. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, protect with straw mulch and water with fine spray.

3.5 LAWN RENOVATION

A. Renovate existing lawn.

B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
2. Provide new topsoil as required.

C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.

D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

E. Mow, dethatch, core aerate, and rake existing lawn.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).

I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches (100 mm) of existing soil. Provide new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch and sod as required for new lawns.

K. Water newly planted areas and keep moist until new lawn is established.

3.6 LAWN MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water lawn with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

C. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass to a height of 1-1/2 to 2 inches (38 to 50 mm).

D. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to lawn area.

3.7 SATISFACTORY LAWNS

A. Lawn installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 95 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after lawn is established.

END OF SECTION 329200

SECTION 329300 - EXTERIOR PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

Unless specifically indicated otherwise, this Section includes furnishing of materials, equipment, and labor necessary for the complete installation of trees, plants, and ground covers, including but not limited to the following items:

1. Tree staking
2. Planting of trees, shrubs, perennials.
3. Mulching and soil amendments
4. Warranty
5. Weed barrier.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

D. Clump: Where three or more young trees were planted in a group and have grown together as a single tree having three or more main stems or trunks.

E. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

H. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.

I. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

J. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

K. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For qualified landscape Installer.

C. Planting Schedule: Indicating anticipated planting dates for exterior plants.

D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

E. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Top soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above the ground for trees up to 4-inch caliper size, and 12 inches above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

F. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

G. Preinstallation Conference General Landscaping: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

B. Do not prune trees and shrubs before delivery except as approved by Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery and handling.

C. Handle planting stock by root ball.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.

B. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Installer's standard form in which Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, abuse by Owner, or incidents that are beyond Contractor's control.

b. Structural failures including plantings falling or blowing over.
c. Faulty operation of tree stabilization.

2. Warranty Periods from Date of Contract Completion:

a. Warrant plants for the duration of one full growing season after planting and shall be alive and in satisfactory growth at the end of the warranty period. The growing season is defined as one full year after acceptance of planting, in writing, but not before Substantial Completion.

3. Include the following remedial actions as a minimum:

a. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
b. At the end of the warranty period, the Architect will make observation upon written notice requesting such inspection, submitted by the Contractor at least 10 days before the anticipated date.
c. In case of questions regarding the condition and satisfactory establishment of a rejected plant, the Contractor may elect to allow such plant to remain through another complete growing season at which time the rejected plant, if found to be dead or in an unhealthy or badly impaired condition, shall be replaced.
d. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
e. A limit of one replacement of each exterior plant will be required except for losses or replacements due to failure to comply with requirements.
f. Provide extended warranty for replaced plant materials; warranty period equal to original warranty period and from date of replacement.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below.

1. Maintenance Period: Three months from date of Contract Completion.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Place no planting, except ground cover, vines, and perennials, closer than 2 feet to pavements or structures.

C. Plants shall have a habit of growth that is normal for the species and shall be sound, healthy, vigorous, and free from insect pests, plant diseases, and injuries.

D. Trees shall have straight trunks with the leader intact, undamaged, and uncut. Old cuts or abrasions shall be completely calloused over. Branching must be well developed and not one sided.

E. Provide trees and shrubs of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

F. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

G. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

H. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

I. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

A. Type 1 and Type 2 (Slower Growth) Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

1. Provide balled and burlapped trees.
2. Branching Height: One-half of tree height.
3. 2 1/2 inch caliper.

B. Small Upright or Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:

1. Stem Form: Single trunk.
2. Provide balled and burlapped trees.
3. 1 3/4 inch caliper

2.3 DECIDUOUS SHRUBS

A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

1. Shrub sizes indicated are sizes after pruning.
2. Provide balled and burlapped, balled and potted, or container-grown shrubs.
3. 30 inch height.

2.4 CONIFEROUS EVERGREEN SHRUBS

A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

1. 7 foot minimum height, 24 inch spread.

2.5 CONIFEROUS EVERGREEN TREES

A. Form and Size: Normal-quality, well-balanced, dense and uniform, coniferous evergreen trees, of type, height, spread, and shape required, complying with ANSI Z60.1.

1. 7 foot minimum height

2.6 PLANT MATERIALS

A. Form and Size: Normal-quality, perennial plans, of type, size required and indicted on Drawings, complying with ANSI Z60.1.

1. Container sizes and other requirements indicated on Drawings.

2.7 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2.8 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Lime (if required as a result of tests made under preceding Part 1): ASTM 605, ground agricultural limestone(Dolomite) containing not less than 85 percent of total carbonates and shall be ground to such a fineness that 50 percent will pass through a 100 mesh sieve and 90 percent will pass through a 20 mesh sieve. Coarser material will be acceptable, provided the specified rates of application are increased proportionately.
2. Provide lime in form of dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through no. 7 sieve and a maximum 10 percent passing through No. 40 sieve.

C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.9 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. of loose sawdust or ground bark.

2.10 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.11 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood bark.

2.12 WEED-CONTROL BARRIERS

A. Nonwoven Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum.

2.13 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch in diameter.

    a. Application: 2 inch or less caliper trees.

4. Guy Cable: 5 strand, 3/16 inch diameter, galvanized steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8 inch galvanized eyebolts.
    a. Application: Greater than 2 inch caliper trees.

5. Hose Chafing Guards: Reinforced rubber or plastic hose at least 1/2 inch in diameter, black, cut to lengths required to protect tree trunks from damage.
6. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

2.14 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch-wide minimum, with stretch factor of 33 percent.

C. Pre-Emergent Herbicide: To kill generating weed seedlings, apply one of the following pre-emergent herbicides at manufacturer’s recommended rate:

1. Oryzalin (Surflan®).
2. Simazin (Princep®).
3. Trifluralin (Treflan®).

D. Post-Emergent Herbicide: To kill emergent weeds during maintenance period, apply one of the following post-emergent herbicides at manufacturer’s recommended rate:

1. Sethoxydim (Poast®).
2. Fluazifop (Fusilade®).
3. Glyphosate (Roundup®).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before planting. Make minor adjustments as required.

D. Lay out exterior plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

E. Trunk Wrapping: Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.

F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 6 inches . Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply superphosphate fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Provide mulched planting beds prepared to receive scheduled perennial plantings as indicated on the Drawings. Mulched areas shall be mechanically edged. Beds shall have a minimum of 6 inches of topsoil, prepared or amended to meet testing requirements. Prior to planting in prepared soil, install weed barrier and mulch to 2.5 inch depth.

1. Planting beds adjacent to building shall be sloped away from building foundation a minimum of 1/2 inch per foot.
2. Planting bed islands or peninsulas shall be mounded near center and sloped outward a minimum of 1 inch per foot.
3. Prior to Contract Completion and after lawn is established, mechanically edge the perimeter of all planting beds. Remove excess materials from Site.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Pits and Trenches: Excavate circular pits with vertical sides. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.

1. Excavate approximately 12 inches wider than ball diameter for balled and burlapped, balled and potted and container-grown stock.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. If drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

B. Only satisfactory subsoil removed from excavations may be used as backfill when amended with additional organic material (such as composted cow manure and/or sphagnum peat moss).

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs. In poorly drained areas, it may be necessary to plant the trees and shrubs higher than normal.

3.5 TREE AND SHRUB PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

B. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.

1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. Place and tamp final layer of planting soil mix. Once backfill is complete, create a soil saucer around the top of the planting hole. Water the plant by inserting the end of a hose into the planting hole. Water until seepage is noted, at top of soil, on the opposite side of the plant.

C. Set balled and potted and container-grown stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.

1. Carefully remove root ball from container without damaging root ball or plant.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

D. Organic Mulching: Apply 4-inch average thickness of organic mulch. Exception, next to tree or plant, there should only be a feathering of mulch applied.

E. Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.

F. Trunk Wrapping: Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling.

3.6 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees and shrubs as directed by Architect.

C. Prune, thin, and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character.

3.7 TREE STABILIZATION

A. Trunk Stabilization: Unless otherwise indicated, provide trunk stabilization as follows:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Use 2 stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; 3 stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
4. Support trees with two strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Guying and Staking: Guy and stake trees exceeding 14 feet in height and more than 3 inches in caliper unless otherwise indicated. Securely attach no fewer than 3 guys to stakes 30 inches long, driven to grade.

1. For trees more than 6 inches in caliper, anchor guys to pressure-preservative-treated deadmen 8 inches in diameter and 48 inches long buried at least 36 inches below grade. Provide turnbuckle for each guy wire and tighten securely.
2. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with strands of cable or multiple strands of tie wire encased in hose sections at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
4. Attach flags to each guy wire, 30 inches above finish grade.
5. Paint turnbuckles with luminescent white paint.

3.8 PLANT MAINTENANCE

A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing stakes and guy supports and root-ball stabilization, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.

B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

C. Roses shall be mulched each December with composted cow manure. Dead wood should be removed in Spring.

3.9 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.10 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION