PROJECT MANUAL

# SUNY ECC North Campus Kittinger Hall Classroom Infrastructure Phase 1 Improvements

## Volume 3

6205 Main Street
Williamsville New York 14221
**DATE: January 6, 2025**

ECDPW PROJECT #: 2021-956-01
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## END OF SECTION 00 0200

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 22.

### 1.02 SCOPE OF WORK

A. Include in bid all labor, materials, tools, plant, transportation, excavation, equipment, insurance, temporary protection, permits, taxes and all necessary and related items required to provide complete and operational systems shown and described.

B. References to codes and Standards called for in the Contract Documents mean the latest edition, amendment and revisions to the codes and standards in effect on the date of these Contract Documents.

C. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:

1. Fire Stopping.

2. Cutting and Patching.

D. Contract shall include, but not be limited to:

1. Plumbing.

### 1.03 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected, and tested in accordance with the governing rules and regulations of federal, state, and local governmental agencies.

B. The following is a list of codes and standards that will apply to this project:

1. 2020 Building Code of New York State (BCNYS).

2. 2020 Existing Building Code of New York State (EBCNYS).

3. 2020 Energy Conservation Construction Code New York State (ECCCNYS).

4. ASHRAE Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings.

5. 2020 Plumbing Code of New York State (PCNYS).

6. 2020 Fuel Gas Code of New York State (FGCNYS).

7. New York State Department of Labor Rules and Regulations.

8. New York State Department of Health.

9. Federal Occupational Safety and Health Administration - OSHA.

10. National Life Safety Code, NFPA 101.

11. National Electrical Code, NFPA 70.

12. Local Codes and Ordinances for the City of Jamestown.

13. NEMA Standards.

14. Underwriters Laboratory (UL).

15. Factory Mutual and/or Owner's Insurance Carrier.

16. National Fire Protection Association (NFPA) - All chapters.

17. New York State Education Department - "Manual of Planning Standards."

18. Town of Amherst Plumbing Department.

**1.04 LICENSING & PERMITS**

A. The Contractor shall hold a license to perform the work as issued by the State of New York.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid.

C. Refer to General Conditions of the Contract for additional requirements.

**1.05 GLOSSARY**

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| ACI | American Concrete Institute |
| ADA | Americans with Disabilities Act |
| AGA | American Gas Association |
| AGCA | Associated General Contractors of America, Inc. |
| AIA | American Institute of Architects |
| AISC | American Institute of Steel Construction |
| AMCA | Air Moving and Conditioning Association |
| ANSI | American National Standards Institute |
| ARI | Air-Conditioning and Refrigeration Institute |
| ASHRAE | American Society of Heating, Refrigeration and Air-Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASPE | American Society of Plumbing Engineers |
| ASTM | American Society for Testing Materials |
| AWSC | American Welding Society Code |
| AWWA | American Water Works Association |
| EIA | Electronic Industries Association |
| FCC | Federal Communications Commission |
| FM | Factory Mutual Insurance Company |
| IEEE | Institute of Electrical and Electronics Engineers |
| IRI | Industrial Risk Insurers |
| ISO | International Standards Organization |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers' Association |
| NESC | National Electrical Safety Code |
| NFPA | National Fire Protection Association |
| NYBFU | New York Board of Fire Underwriters |
| NYS/DEC | New York State Department of Environmental Conservation |
| NYS/UFBC | New York State Uniform Fire Prevention and Building Code |
| OSHA | Occupational Safety and Health Administration |

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|---|---|
| SHI | Steel Boiler Institute |
| SMACNA | Sheet Metal and Air Conditioning Contractors National Association |
| TIA | Telecommunications Industry Association |
| UFPO | Underground Facilities Protective Organization |
| UL | Underwriter's Laboratories, Inc. |

**1.06 DEFINITIONS**

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| Approved / Approval | Written permission to use a material or system. |
| As Called For | Materials, equipment including the execution specified/shown in the contract documents. |
| Code Requirements | Minimum requirements. |
| Concealed | Work installed in pipe and duct shafts, chases, or recesses, inside walls, above ceilings, in slabs or below grade. |
| Design Equipment | Refer to the article, BASIS OF DESIGN. |
| Design Make | Refer to the article, BASIS OF DESIGN. |
| Equal or Equivalent | Equally acceptable as determined by Owner's Representative |
| Exposed | Work is not identified as concealed. |
| Final Acceptance | Owner acceptance of the project from Contractor upon certification by Owner's Representative. |
| Furnish | Supply and deliver to installation location. |
| Furnished by Others | Receive delivery at job site or where called for and install. |
| Inspection | Visual observations by Owner's site Representative. |
| Install | Mount and connect equipment and associated materials ready for use. |
| Labeled | Refers to classification by a standards agency. |
| Make | Refer to the article, BASIS OF DESIGN. |
| Or Approved Equal | Approved equal or equivalent as determined by Owner's Representative. |
| Owner's Representative | The Prime Professional |
| Prime Professional | Architect or Engineer having a contract directly with the Owner for professional services. |
| Provide | Furnish, install, and connect ready for use. |
| Relocate | Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use. |
| Replace | Remove and provide new item. |
| Review | A general contractual conformance check of specified products. |
| Rough-in | Pipe, duct, conduit, equipment layout and installation. |
| Satisfactory | As specified in contract documents. |
| Site Representative | Construction Manager or Owner's Inspector at the work site. |

Refer to General Conditions of the Contract for additional definitions.

**1.07 BASIS OF DESIGN**

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in work of all other trades, at no increase in any contract. Provide larger motors, electrical feeders, circuit breakers, equipment, additional control devices, valves, fittings, and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

### 1.08 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.

### 1.09 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD .dwg or MicroStation. dgn format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors' responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors' coordination shop drawings is to account for all trades, field conditions, and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts because of the Contractors' failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. A request must be made in writing to the Engineer with the requested individual files. The contractor will then be sent a CAD Release Form and must sign the form to obtain electronic drawings.

### 1.010 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Owner's Representative for resolution.

D. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, cutting and patching.

E. All work shall be done in a neat and workmanlike manner. All methods of construction, and details of workmanship, which are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

A. Provide Materials That Meet the Following Minimum Requirements:

1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.

2. All equipment and material for which there is a listing service shall bear a UL label.

3. Potable water systems and equipment shall be built according to AWWA Standards.

4. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA/CSA label.

5. Electrical equipment and systems shall meet UL Standards and requirements of the N.E.C. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with these requirements.

6. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

7. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

**2.02 SUBSTITUTIONS**

A. The Materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions, and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted in writing to the Architect and Engineer a minimum of ten (10) days prior to the date for receipt of Bids.

1. Each request shall include the name of the proposed material or equipment being substituted, cut sheets, installation drawings, performance and test data, warranties, and location of three (3) similar installations with reference names of Owner or Facility personnel responsible for maintaining equipment.

2. At that time, the equipment will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders.

C. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are unacceptable and will not be considered.

D. Requests for substitution shall be made only by the contractor. Requests for substitution from sales representatives, vendors or suppliers are unacceptable and will not be considered.

**2.03 FACTORY-ASSEMBLED PRODUCTS**

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.

1. All components of an assembled unit need not be products of same manufacturer.

2. Constituent parts which are alike shall be product of a single manufacturer.

3. Components shall be compatible with each other and with the total assembly for intended service.

4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

**2.04 COMPATIBILITY OF RELATED EQUIPMENT**

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

**2.05 SPECIAL TOOLS**

A. If any part of equipment requires a special tool for assembly, adjustment, or maintenance thereof and such tool is not readily available on commercial tool market, it shall be furnished by the Contractor.

**2.06 FIRE STOPPING**

A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:

1. Dow Corning Fire-Stop System Foams and Sealants.

2. Nelson Electric Fire-Stop System Putty, CLK and WRP.

3. Thomas & Betts - S-100 FS500/600,

4. Carborundum Fyre Putty.

**PART 3 - EXECUTION**

**3.01 SHOP DRAWINGS/PRODUCT DATA/SAMPLES**

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections.

B. Shop drawings shall be dated and contain the following information. Incomplete submittals will not be accepted. Number each submittal.

1. Name of project.

2. Name of prime professional.

3. Name of prime contractor.

4. Description or names of equipment, materials, and items; and complete identification of locations at which materials or equipment are to be installed.

C. All products specified in an individual Division 22 section shall be submitted at the same time.

D. Indicate deviations from contract requirements on Letter of Transmittal.

E. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

## 3.02 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings drawn at not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as Follows:

1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be in AutoCAD format of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

2. HVAC Contract will provide AutoCAD files and/or prints and submit the base plan to all major trades' Contractors.

3. Electrical, Plumbing and Fire Protection Contracts will each draft location of piping, conduits and equipment on the base plan as provided by the HVAC Contract such that a complete coordination of all trades is represented, and areas of conflict and recommended resolutions are noted.

4. Do not install equipment, equipment foundations or piping until Coordination drawings have been approved.

## 3.03 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall always assume responsibility for Construction Safety and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature required to provide safe conditions for all workers and site visitors.

## 3.04 EXISTING SYSTEMS AND CONDITIONS

A. Prior to beginning work inspect and test all existing systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, which is determined to have been caused by the work in this contract.

C. The Owner’s representative shall determine if the contractor has damaged existing systems or construction and approve the repairs.

## 3.05 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The contractor shall be responsible for coordination of all required removal work, coring, cutting, and patching with the Owner's asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all his workers, supervisory personnel, subcontractors, Owner, and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Refer to Division 2 Sections for further requirements.

## 3.06 REMOVALS

A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean, and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, tubing, supports, fixtures, etc. Visit each room, crawl spaces and roofs to determine total Scope of Work.

B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation, conduit, panels, and all hangers, including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, conduits and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

C. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction.

## 3.07 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

## 3.08 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the Owner's representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all ducts, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication, and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers, and other items. Do not rough-in-contract work without reflected ceiling location plans.

2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to ensure proper location and size of connections to ensure proper functioning of all systems and equipment. Obtain written authorization from the Owner's representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by this contractor at no expense to the Owner.

3. For equipment and connections provided in this contract, prepare roughing drawings as follows:

a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.

b. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.

4. Where more than one trade is involved in an area, space, or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary to meet field conditions or to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

## 3.09 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch, cut, or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

### 3.010 CONCEALMENT

A. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

### 3.011 FIRE-STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:

1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.

3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

4. The methods used shall incorporate qualities which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling, and resulting reduction in fire rating.

5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.

6. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

### 3.012 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support plumbing work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

### 3.013 PAINTING

A. This Contract Includes the following:

1. Painting for all cut and patch work performed as part of Division 22 contract.

2. Painting required for touch-up of surfaces damaged due to the installation of division 22 work.

3. Painting as required to repair finish of equipment furnished.

4. Refer to Division 9 Sections for general description of materials and methods.

5. Painting as called for on Division 22 Drawings.

### 3.014 ADDITIONAL ENGINEERING SERVICES

A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

B. In the event that the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's expense in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

### 3.015 ALL TRADES TEMPORARY HEAT

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

### 3.016 TEMPORARY FACILITIES

A. Refer to the standard General Conditions of the contract for Construction and Supplemental General Conditions.

1. Continuity of operation of existing facilities will require temporary installation or relocation of equipment and piping.

2. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.

3. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining pressurized.

### 3.017 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:

1. Thoroughly clean entire installation, both exposed surfaces and interiors.

2. Remove all debris caused by work.

3. Remove tools, surplus, materials, when work is finally accepted.

### 3.018 PLUMBING EQUIPMENT CONNECTIONS

A. Provide complete plumbing connections to all plumbing equipment. Provide control connections to equipment where indicated on the drawings. Provide valves on piping ahead of each piece of equipment.

B. Provide all piping, trim, accessories, and connections as required for proper equipment operation of Equipment provided by this contract, Owner-Furnished Equipment and Equipment furnished by other contracts,

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

## 3.019 PLUMBING INSTALLATIONS

A. All installations shall comply with the following requirements:

1. Coordinate plumbing systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.

2. The Architect shall control the placement of all wall and ceiling mounted plumbing equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.

3. Verify all dimensions with field measurements.

4. Arrange for all chases, slots, and openings in other building components, which are not indicated on drawings, to allow for plumbing installations.

5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule.

7. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.

9. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the Owner’s representative.

12. All finished equipment surfaces damaged during construction shall be brought to “as new” condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.

13. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

14. No plumbing equipment shall be hidden or covered up prior to inspection by the Owner's representative. All work that is determined to be unsatisfactory shall be corrected immediately.

15. All plumbing work shall be installed level and plumb, parallel, and perpendicular to other building systems and components.

16. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

17. Install access panels or doors where units are concealed behind finished surfaces.

## 3.020 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest edition of the NEC.

B. Provide all power wiring, electric equipment, switches, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts. Provide control wiring where noted in the documents.

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

## 3.021 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Always maintain existing systems in operation within all rooms of building. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary plumbing and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing facilities or services.

## 3.022 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owner's designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer's certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e., variable frequency drive and pumps) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Refer to Division 1 Sections for additional requirements.

### 3.023 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings, and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions, and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer Representative and service agency for all major equipment items. Bind above items in a three-ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance.

### 3.024 RECORD DOCUMENTS

A. Prepare and provide record documents in accordance with Division 1 Sections. In addition to those requirements provide the following:

1. Utilities below floors, slabs, and grade: During construction, maintain accurate records of all final locations and inverts for all services inside and outside of the buildings, beneath grade and below floors.

2. Take dimensions from a given fixed benchmark, such as the corner of a building, and neatly and clearly indicate same on Record Drawings.

3. Provide Record Drawings for all Contract Work.

4. Incorporate all field changes, change orders and other modifications into the final Record Drawings.

B. Provide record documents electronically on a disk or flash drive to the Owner. Also provide one (1) set of prints to Owner.

### 3.025 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre-designated site.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

### 1.02 SUBMITTALS

A. Schedule of all pipe materials, fittings, and connections to be utilized on this Project.

1. Pipe and fitting material data sheets identifying compliance with specified approvals and listings.

## PART 2 - PRODUCTS

### 2.01 GENERAL

A. All piping and fittings used on this Project shall be new and marked with manufacturer's name; and shall comply with all applicable ASTM and ANSI Standards.

B. All water distribution pipe and fittings shall conform to NSF-61.

C. All drinking water system components, including pipe and fittings, shall conform to NSF-372.

### 2.02 STEEL PIPING AND FITTINGS

A. Pipe: ASTM A53, or ASTM A106 seamless, Schedule 40 weight, black finish as called for, ends threaded for screwed (threaded) connections.

B. Fittings: Same material and pressure class as adjoining pipe.

1. Threaded fittings: Malleable iron, black or galvanized finish as called for.

C. Joints and Connections:

1. Threaded connections:

a) Unions: ASA malleable cast iron, bronze to iron seat, 300 lb. wwp; for sizes 2-inch and smaller.

### 2.03 COPPER PIPE AND SOLDER FITTINGS

A. Pipe, Above ground: Hard temper, ASTM B88; Type L, or DWV, as called for. Soft temper only as called for. Plans show copper tube sizes.

B. Tees, Elbows, Reducers: Wrought copper; solder end connections; ASME B16.22; ASTM B828.

1. Cast copper alloy fittings are prohibited for medical vacuum piping systems.

C. Unions And Flanges:

1. 2-inch and smaller: Unions, solder type, wrought copper, ground joint, 150 lb. swp.

2. 2-1/2-inch and larger: Flanged, wrought copper, companion type, ASME drilled, solder connection, 150 lb. swp.

D. Solder Materials: No-lead solder, using alloys made from tin, copper, silver, and nickel.

1. No-lead solder and flux shall comply with requirements of NSF-372, ASTM B813, ASTM B32.

2. Make: Harris "Bridgit", Lucas-Milhaupt Warwick "Silverbright 100", Canfield Technologies "100% Watersafe".

**2.04 COPPER PIPE AND PRESS FITTINGS**

A. Pipe Standard: Conforming to ASTM B75 or B88, Type 'L' as called for. Plans show copper tube sizes.

B. Fitting Standard: Conforming to ASME B16.18, ASME B16.22 or ASME B16.26.

C. Press Fitting: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM and comply with NSF-61 requirements.

**2.05 SOIL PIPE AND FITTINGS**

A. Pipe: ASTM A74 service weight cast iron, coated.

B. Fittings: Service weight type with "push-on" type fittings with ASTM C564 extra heavy neoprene gasket of same manufacturer as piping.

C. No-Hub:

1. Pipe: ASTM A888 no-hub cast iron, coated.

2. Fittings: Cast iron no-hub pattern with neoprene gasket and 24-gauge, Type 304 stainless-steel, 4-band/bolt heavy-duty clamp assembly; ASTM C1540.

a) Make: Charlotte Pipe, Clamp-All, Husky, Tyler "Widebody."

**2.06 SPECIAL FITTINGS**

A. Cast Iron To Lead Pipe: Red brass ferrules and wiped joints. Caulk ferrule into cast iron hub.

B. Copper To Cast Iron: Cast bronze, cast iron to sweat adapter.

C. Copper To Steel Piping:

1. Cast bronze copper to iron male or female adapter with shoulder for drainage piping only.

2. Dielectric pipe fittings.

D. No-Hub, Cast Iron, Glass, Polypropylene Or High Silicon Cast Iron: Proper adapter to piping being connected.

**2.07 DIELECTRIC PIPE FITTINGS**

A. Tensile strength, ASME B16.8, union 250 psi, or flange design, 175 psi, pressure rating, at 210 Deg. F, threaded or solder joint, constructed to prevent gasket from squeezing into internal opening.

B. Acceptable Manufacturer: Epco, Capitol Manufacturing, Watts, or approved equal.

## 2.08 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps: Anvil International, Carpenter & Patterson, Cooper B-Line, PHD Manufacturing.

B. Hangers:

1. Adjustable, wrought malleable iron or steel. Copper plated or PVC coated where in contact with copper piping. Cadmium plated or galvanized for exterior.

2. Adjustable ring type where piping is installed directly on hanger for piping 3 inch and smaller.

3. Adjustable steel clevis type for piping 4 inch and larger.

4. Nuts and rods with electroplated zinc or cadmium (0.005 inch minimum) finish.

C. Spacing Schedule:

1. Pipe Hangers:

a) Plumbing Piping: Hanger spacing shall comply with Section 308 and Table 308.5 of the 2020 Plumbing Code of New York State (PCNYS).

b) Fuel Gas Piping: Hanger spacing shall comply with Section 407, Section 415, and Table 415.1 of the 2020 Fuel Gas Code of New York State (FGCNYS).

2. Cast-iron pipe: Each horizontal joint, 5-feet maximum O.C.

D. Cast Iron No-Hub Supports:

1. In accordance with manufacturers recommendations.

2. Vertical piping supported at each stack base and at each floor. Freestanding vertical pipe should be adequately staked or braced during construction to maintain alignment. Bases of stacks shall be supported on concrete, brick laid in cement mortar, metal brackets attached to the building construction or by other methods approved by the Owner's Representative.

3. Horizontal piping supported within 24 inch each side of the coupling joint at 10-foot intervals for 10-foot pipe lengths and at 5-foot intervals for 5-foot pipe lengths. Supports or hangers placed to maintain alignment and grade with provision made to prevent shear. Greater than 3-inch diameter pipe braced at changes of direction to prevent horizontal movement.

E. Piping systems with material not listed above, supported, and protected in accordance with manufacturer's recommendations.

F. Concrete Inserts: Zinc plated steel body, malleable iron nut. MSS SP-58 Type 18.

1. Insert for Lightweight Concrete: Anvil Fig. #285, maximum loading 400 lbs.

2. Insert for Concrete: Anvil Fig. #281, maximum loading 1,000 lbs.

G. Supports:

1. For weights under 1000 lbs.: “Drill-In" inserts equal to Phillips "Red Head" "U" Channel, beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.

2. For weights above 1000 lbs.: Drill through floor slabs and provide flat flush plate welded to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs.

3. For metal decks: Drill hole through for hanger rods and imbed a welded plate in concrete or use Phillips "Red Head" devices designed for this application, with a safety factor of four.

H. Trapeze Hangers:

1. Hangers shall be supported with rod sized with a safety factor of four.

2. May be manufactured type "U" shaped channel, or suitable angle iron or channel.

3. Securely fasten piping to trapeze with "U" bolt or straps, dissimilar metals shall not touch, use isolation gaskets.

4. Acceptable Manufacturer: Globestrut, Kindorf, Unistrut, B-Line, or approved equal.

I. Pipe Insulation Shields:

1. Galvanized steel shields, minimum 180° arc, unless otherwise indicated. MSS SP-58 Type 40.

2. Shields for use with hangers and supports per the following schedule:

| Pipe Size | Shield Length | Shield Gauge |
|---|---|---|
| 1/2" – 3" | 12" | 18 |
| 4" | 12" | 16 |
| 5" – 6" | 18" | 16 |

## 2.09 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast-iron polished chrome, split hinge type with setscrew, high plates where required for extended sleeves. Chrome plated in finished areas and at plumbing fixtures.

## 2.010 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL AND FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Through-Penetration Firestop Systems". The system shall meet the standard fire test for Through-Penetration Firestop Systems designated ASTM E814.

B. Firestop system seals shall be provided at locations where piping pass through fire rated wall, floor/ceiling, or ceiling/roof assembly.

C. Minimum required fire-resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform to the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

## 2.011 PIPING MATERIALS AND SCHEDULE

A. See Exhibit P1, "Plumbing Piping Materials", at the end of this Section for general plumbing piping systems.

B. See Exhibit P2, "Fuel Systems Piping Materials", at the end of this Section for natural gas piping systems.

## PART 3 - EXECUTION

### 3.01 EQUIPMENT AND SYSTEMS

A. Install equipment and systems in accordance with provisions of each applicable Section of these Specifications, and Local/State Codes/Regulations having jurisdiction.

B. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring.

C. Arrange piping at equipment with necessary offsets, unions, flanges, and valves, to allow for easy part removal and maintenance.

D. Offset piping and change elevation as required to coordinate with other Work. Avoid contact with other mechanical or electrical systems. Make changes in direction and branch connections with fittings.

E. Provide adequate means of draining and venting systems.

F. Conceal piping unless otherwise called for. Do not install valves, unions, and flanges in inaccessible locations.

G. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction.

H. Install piping parallel with lines of building, properly spaced to provide clearance for insulation.

I. Materials within a system and between systems shall be consistent. If this is not possible, install dielectric fittings.

### 3.02 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, or from other piping, nor by vertical expansion bolts. Support piping with individual hangers from concrete inserts, welded supports, or beam clamps of proper configuration and loading design requirements for each location; replace if not suitable. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing, using proper diameter rod for pipe size.

B. Provide oversized hangers where insulation/supports must pass between pipe and hanger.

1. Provide pipe insulation shield at all points of support for insulated piping. Center shields on all hangers and supports outside of insulation. Install shields in manner to prevent cutting or puncturing insulation jacket.

C. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible; "C" type not permitted on joists.

### 3.03 PIPE CONNECTIONS

A. No-Lead Solder Connections: Nonacid flux; clean off excess flux and solder. Solder and flux shall comply with requirements of NSF-372.

B. Press Fitting Connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

C. Threaded Connections: Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be specifically selected for each application.

D. Dielectric Pipe Fittings: Protect fittings from excessive heat.

**3.04 ESCUTCHEON PLATES**

A. Provide polished chrome escutcheon plates for all exposed piping passing through walls.

**3.05 TESTS**

A. Refer to other Division 22 Sections for testing of Plumbing Systems.

**3.06 PIPELINE SIZING**

A. Pipe sizes called for are to be maintained. Pipe size changes made only as reviewed by Owner's Representative. Where discrepancy in size occurs, a larger size shall be provided.

**EXHIBIT "P1" – PLUMBING PIPING MATERIALS**
(Notes at end of Exhibit "P1")

| Service | Pipe Materials | Fittings | Connections |
|---|---|---|---|
| Domestic water interior/hot, cold, and circulating 3" and smaller (interior, not buried) | Type L copper<br><br>Type L copper | Wrought copper<br><br>Wrought copper | No-lead solder<br><br>Press type |
| Sanitary waste and vent (interior, not buried) | Service weight cast iron soil pipe<br><br>Type DWV copper | Cast iron hub and spigot No-hub<br><br>Wrought Copper drainage pattern | Neoprene gasket compression type, no-hub neoprene gasket and stainless-steel clamp assembly<br><br>No-lead solder |
| Compressed Air (interior, not buried) | Schedule 40, black steel | 2" and smaller malleable | Threaded |

**EXHIBIT "P2" – FUEL SYSTEMS PIPING MATERIALS**

(Notes at end of Exhibit "P2")

| Service | Pipe Materials | Fittings | Connections |
|---|---|---|---|
| Natural gas (interior, not buried) | Schedule 40, black steel, paint with 3 coats. | 2" and smaller malleable. Paint fittings with 3 coats. | Threaded |

NOTES FOR EXHIBIT "P2":

NOTE 1: Paint interior natural gas piping with one (1) coat rust inhibiting primer and 2 coats semi-gloss enamel, color shall be bright yellow. Apply paint in accordance with manufacturer's directions. Remove spilled and splattered paint from all surfaces.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

### 1.02 SUBMITTALS

A. All valves and accessories listed under "Part 2 – Products" of this Section.

1. Submit cut sheets, specifications, and dimensioned drawings.

2. Show compliance with ANSI/NSF-372 for valves intended to supply drinking water.

## PART 2 - PRODUCTS

### 2.01 VALVES - GENERAL

A. Valves shall have following requirements:

1. Working pressure stamped or cast on bodies per MSS SP-25.

2. Stem packing is serviceable without removing valve from line and shall be free of asbestos.

3. Valves intended to supply drinking water shall comply with requirements of ANSI/NSF-61 and ANSI/NSF-372.

B. Makes:

1. Ball valves: Watts, Apollo (Conbraco), Hammond, Milwaukee, or Nibco.

### 2.02 BALL VALVES

A. 2-inch and smaller: Lead-free brass body with hard chrome-plated lead-free brass ball and stem, full port opening, teflon seats, end entrance, 600 #WOG, 150 #WSP. Threaded ends, Watts model #LFFBV-3C. Solder (sweat) ends, Watts model #LFFBVS-3C.

1. Valve shall have separate packing nut and handle nut.

B. Press Fitting Connections:

1. 2-inch and smaller: Lead-free brass or bronze body with stainless steel or lead-free brass ball and stem. Full port opening, 2 piece, teflon seats, Press Fitting end connections, 200 #WSP. Watts model #LFFBV-3-Press-M1.

2. Sealing elements for end connections shall be EPDM, factory installed.

### 2.03 GAS AND COMPRESSED AIR VALVES

A. 2-inch and smaller: Brass body, threaded ends, full port ball valve, UL listed, CSA approved to 0.5 psig and 5 psig. Watts model #FBV-3C.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. General:

1. Provide valves of type called for and where required to service equipment and fixtures.

2. Use extreme care and caution when soldering valve connections to piping to prevent valve seat damage. Apply heat with the flame directed away from the center of the valve body. Inspect all valves after soldering, tighten valve packing nut and adjust if required to ensure valve operates properly. Replace all damaged valves.

3. Install Press Fitting connection type ball valves in accordance with manufacturer's written installation instructions. Installer shall be a qualified installer; trained per the manufacturer's requirements.

    a. Ball valves shall be installed using the proper tool, actuator, jaws, and rings as instructed by the manufacturer.

4. Provide valves where shown on the Contract Drawings.

5. Provide extended stem on insulated valves so valve handle is outside of insulation.

6. Locate valves with stems at, or above, horizontal positions.

7. Install valves in accordance with manufacturer's written installation instructions.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services as required for the complete installation designed in Contract Documents.

### 1.02 QUALIFICATIONS

A. All identification devices shall comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles.

### 1.03 SUBMITTALS

A. Submit product data for each identification material and device, and for all items specified under “Part 2 - Products” of this Section.

B. Submit valve schedule for all piping systems typewritten on 8 1/2-inch x 11-inch paper, indicating code number, location, and valve function.

C. Submit schedule of piping, equipment, and valve identification for review before labeling. Confirm naming/numbering is consistent with Owner’s naming/numbering convention prior to labeling.

### 1.04 ACCEPTABLE MANUFACTURERS

A. Brady Co., Brimar Industries, Craftmark, Seton, or approved equal.

## PART 2 - PRODUCTS

### 2.01 GENERAL

A. Provide manufacturer's products of categories and types required for each application.

### 2.02 PIPING IDENTIFICATION

A. Pipe Labels (Inside buildings):

1. Piping/Insulation with outside diameter of 8-inches and less: Provide self- adhesive, vinyl press and peel type markers with directional flow arrows, pipe temperature -40 degrees F to 175 degrees F. UV resistance and legend printed four (4) times for 360-degree visibility.

B. Pipe labels shall conform to the following identification table:

| PIPE SERVICE | IDENTIFICATION/LABEL |
|---|---|
| Domestic Cold Water | DOMESTIC COLD WATER |
| Domestic Hot Water | DOMESTIC HOT WATER |
| Domestic Hot Water Re-circulation | DOMESTIC HOT WATER RETURN |
| Natural Gas | NATURAL GAS |
| Compressed Air | COMPRESSED AIR |

## 2.03 VALVE IDENTIFICATION

A. Valve Tags:

1. Standard brass valve tags, 2" diameter with 1/2" high numerals. Identify all plumbing services with 1/4" letters above the valve number (“PLBG.”). Attach to valves using brass “jack” chain and brass “S” hook. Make: Seton Style No. M4507 tags, Style No. 16182 chain and Style No. 16195, 6 and 7 No. hooks.

B. Valve Tag Chart:

1. Provide valve tag chart for all valves provided as a part of this project. Include valve tag chart within the O&M manual.

## PART 3 - EXECUTION

## 3.01 GENERAL

A. Provide valve tags for all valves provided on project. Provide a valve tag chart for all valves provided on the project.

B. Provide piping identification with directional flow arrows for all piping provided on project.

1. Provide labels on straight runs of piping. Provide a minimum of one (1) label on capped piping.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

B. Plumbing insulation shall comply with the requirements of the 2020 Energy Conservation Construction Code (ECCCNYS).

### 1.02 SUBMITTALS

A. All items listed under "Part 2 – Products" of this Section.

1. Submit manufacturer's data sheets.

B. Schedule of all insulation applications for this project.

## PART 2 - PRODUCTS

### 2.01 GENERAL

A. Insulation, Jackets, Adhesives, And Coatings, Shall Comply With The Following:

1. Treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments are not permitted.

2. Insulation, including finishes and adhesives on the exterior surfaces of pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as tested by ASTM E84 (NFPA 255) and UL 723 methods.

3. Asbestos or asbestos bearing materials are prohibited.

### 2.02 PIPE INSULATION (RIGID TYPE)

A. Preformed rigid sectional pipe covering, 4 lb. nominal density fiberglass; ASTM C547, Class 1. White Kraft outer surface bonded to aluminum foil and reinforced with fiberglass yarn.

B. Maximum thermal conductivity (k), in units of Btu/sq. ft. hr. $^{o}$F/in.:

| Fluid Operating Temperature | Max. Thermal Conductivity | Mean Rating Temperature |
|---|---|---|
| 40° F - 60° F | 0.27 | 75° F |
| 105° F - 140° F | 0.28 | 100° F |
| Greater than 140° F | 0.29 | 125° F |

### 2.03 METAL JACKETING

A. Aluminum, 0.016 inch thick, Z-joint longitudinal joint; ASTM B209. Transverse closure strip with weatherproof sealing method.

### 2.04 PLASTIC JACKETING

A. PVC jacket, UV-resistant, 20 mill thickness; ASTM D1784, Class 14253-C. Solvent adhesive welded joints.

## 2.05 MAKE

A. Fiberglass: Certainteed, Knauf, Johns Manville, Owens-Corning, or approved equal.

B. Adhesives: Childers, Foster Products, Tremco; numbers designate quality of adhesive.

## 2.06 MATERIALS AND SCHEDULES

A. See Exhibits at the end of this section.

# PART 3 - EXECUTION

## 3.01 GENERAL REQUIREMENTS

A. Provide Thermal Insulation:

1. Insulation is required on piping unless otherwise called for.

2. Install insulation only on clean, dry surfaces and after work has been tested.

3. Install insulation on cold surfaces with continuous unbroken vapor seal.

4. Exposed surfaces shall be white.

5. Pipes shall be individually insulated.

B. Do not cover inspection stampings, openings, petcocks, handholes, manholes, access doors, plugged outlets, air vents, plugged openings or petcocks.

C. Install insulation, accessories, coverings, and jackets in accordance with manufacturer's installation instructions.

## 3.02 PIPE INSULATION

A. Insulate piping systems including fittings, valves, flanges, unions, strainers, and other attachments installed in piping system, whether exposed or concealed.

B. Piping In Exterior Walls, Spaces, Overhangs, Attics, and Or Where Subject To Freezing: Insulate pipe with double the thickness called for.

1. Piping In Wall Chases: In addition to the above, pack chase with loose glass fiber insulation.

C. Plumbing Equipment:

1. Install insulation on exposed hot and cold plumbing piping.

2. Insulation is not required on valves, strainers, and threaded piping, 1 inch and smaller.

3. Provide exposed domestic hot water and waste piping for plumbing fixtures designated for use by people with disabilities with coverings to protect against contact. Refer to Section 224200, Commercial Plumbing Fixtures, for additional information.

D. Joints In Section Pipe Covering Made As Follows:

1. Standard: Longitudinal laps and butt joint sealing strips cemented with Foster 85-20 or factory applied pressure sensitive adhesive lap seal. Stapled with outward clinching staples.

2. Vapor barrier: For cold services, Longitudinal laps and 4-inch vapor barrier strip at butt joints shall be sealed with white Foster 85-20. Seal ends of pipe insulation at valves, flanges, and fittings with white Foster 85-20.

E. Pipe Insulation Shields:

1. Refer to Section 220502, Plumbing Piping Systems and Accessories, for requirements.

2. Provide pipe insulation shield at all points of support for insulated piping. Center shields on all hangers and supports outside of insulation. Install shields in manner to prevent cutting or puncturing insulation jacket.

F. Fittings, Valves And Flanges:

1. Hot and cold water:

a. Concealed: Insulating cement of the same thickness as adjacent pipe insulation. Cold water to be vapor sealed with Foster 30-36 "Seal-Fas".

b. Exposed: Pre-molded fitting covers of the same material and thickness as the adjacent pipe insulation and finished with glass cloth applied and coated with Foster 30-36 "Seal-Fas."

2. Optional: In lieu of the standard method above, the Contractor has the option of using Zeston, Ceel-Co, or Proto. Tape all joints at covers.

a. Fitting covers shall have fiberglass insulation inserts from the factory. Insulation inserts shall have 1.5 pcf minimum density; ASTM C553, Type III.

b. PVC fitting covers shall be UV-resistant.

## 3.03 EXISTING INSULATION

A. Patch existing insulation damaged during the course of the work.

## 3.04 EXISTING WORK

A. Insulate existing piping and equipment as called for on the Contract Drawings. Insulation material and thickness shall comply with Exhibits in this Section.

EXHIBIT "I" - PIPE INSULATION MATERIALS
(Notes are at end of Exhibit "I")

| SERVICE | INSULATION MATERIAL | PIPE SIZE | INSULATION THICKNESS | REMARKS |
|---|---|---|---|---|
| Domestic cold water | Glass fiber | 1-1/2" and larger<br>1-1/4" and smaller | 1"<br>1/2" | |
| Domestic hot water (up to 140°) | Glass fiber | 1-1/2" and larger<br>1-1/4" and smaller | 1-1/2"<br>1" | |
| Domestic hot water return (up to 140°) | Glass fiber | 1-1/2" and larger<br>1-1/4" and smaller | 1-1/2"<br>1" | |

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

### 1.02 QUALITY ASSURANCE

A. Follow all requirements, recommendations and appendices of the following publications, codes, standards, and listings:

1. New York State Health Department: Cross Connection Control Manual.
2. 2020 Plumbing Code of New York State (PCNYS).
3. ANSI/NSF-61, Drinking Water System Components – Health Effects.
4. ANSI/NSF-372, Drinking Water System Components – Lead Content.

### 1.03 SUBMITTALS

A. All items specified under “Part 2 - Products” of this Section.

B. Written certification for domestic water system tests. Submit with O&M Manuals.

C. Lab results from lead testing. Submit results to Owner, Owner’s Representative and Engineer.

## PART 2 - PRODUCTS

### 2.01 DOMESTIC WATER SYSTEMS PIPING

A. Refer to Section 220502, “Plumbing Piping Systems and Accessories” for piping materials.

## PART 3 - EXECUTION

### 3.01 GENERAL

A. Installation shall conform to Article 1.2 of this section and shall be provided in a workmanlike manner as determined by the Owner's Representative and the Contract Specifications.

### 3.02 PIPING

A. Provide dielectric pipe fittings when connecting systems of dissimilar metals. Refer to Section 220502, “Plumbing Piping Systems and Accessories”.

B. Supply piping to all fixtures shall be anchored to prevent movement. Provide additional structural members and supports as required.

### 3.03 ASBESTOS PIPE

A. General: Existing water main piping and/or pipe insulation may contain asbestos. Cutting, drilling or other disturbance of this material shall be conducted as specified by New York State Department of Labor, Industrial Code Rule No. 56 "Asbestos". The methods and procedures specified in New York State Department of Labor, Industrial Code Rule 56 shall constitute minimum measures and shall in no way relieve the Contractor of sole responsibility for the means, methods, techniques, sequences, or safety measures taken in connection with the work.

### 3.04 STERILIZATION

A. Provide sterilization of water piping in accordance with all requirements of the New York State Health Department, Public Water Supply Guides, Division of Sanitary Engineering, Bureau of Public Water Supply.

### 3.05 TESTS AND FLUSHING

A. Provide all necessary items to complete proper testing of all domestic water piping. Isolate existing systems as required.

B. Flush all water piping to remove debris, sediment, dirt, rust, corrosion, and other foreign material. Flush all piping before connecting to fixture faucet and flush valves. Refer to Section 224200, “Commercial Plumbing Fixtures”. Utilize open pipe ends wherever possible.

C. Piping Supplying Domestic Water: Test at 125 psi hydrostatic pressure for two hours. All tests shall be witnessed by Engineer or Owner’s Representative.

D. A successful air test is not acceptable as the final test; however, the Division 22 contractor shall provide interim air testing of piping as construction progresses.

E. Make all leaks tight. No caulking of leaks shall be permitted. Remove and replace all defective fittings, piping, and connections.

F. Collect bacteriological test samples after testing and flushing is complete. A minimum of two (2) samples shall be taken. Locations of samples shall be designated by the Owner’s Representative. Collect samples in sterile bottles and send to NYS DOH approved laboratory for analysis.

1. Submit sample test results to Owner’s Representative.

2. Contractor shall disinfect, flush and re-test domestic water piping until sample test results are satisfactory.

G. Provide one round of testing for each domestic water pipe and outlet for potential lead contamination in the domestic water systems installed under this Contract. Testing of piping shall be in accordance with the requirements outlined in the New York State Department of Health Regulation 10CRR-NY, Subpart 67-4, Lead Testing in School Drinking Water, including the following:

1. Samples shall be collected from all outlets using the first-draw procedures, as defined in Regulation 67-4. A first-draw sample volume of 250 milliliters (mL), shall be collected from a cold or hot water outlet before water is used by anyone. The water shall be motionless in the pipes for a minimum of 8 hours, but not more than 18 hours, before sample collection.

2. All first-draw samples shall be analyzed by a laboratory approved to perform such analyses by the New York State Department of Health’s Environmental Laboratory Approval Program (ELAP). Submit lab analysis reports to the Owner, Owner’s Representative and Engineer.

3. Lab results must show the lead concentration of water for all outlets does not exceed the action level (15 parts per billion) defined in Regulation 67-4 prior to putting water outlets into service. Comply with Response requirements in Regulation 67-4 when lab results exceed the action level.

H. Pay all costs of tests. Perform all tests in a safe manner. Remove all discharged water resulting from testing procedures.

I. Certify in writing that all required domestic water tests have been conducted and successfully completed. Submit all certifications to the Owner's Representative and include within the O&M manual.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

### 1.02 SUBMITTALS

A. All items specified under “Part 2 - Products” of this Section.

B. Submit written certification for sanitary piping system tests. Submit within the O&M Manuals.

## PART 2 - PRODUCTS

### 2.01 PLUMBING DRAINAGE SYSTEM

A. Refer to Section 220502, “Plumbing Piping Systems and Accessories” for piping materials.

## PART 3 – EXECUTION

### 3.01 GENERAL

A. Prior to commencing work, the Contractor shall verify all piping inverts and locations. Any discrepancy between the plans and field conditions shall be reported in writing to the Owner and Engineer within three (3) days of discovery. No work shall start until all discrepancies have been resolved. All costs related to Contractor's failure to verify and/or report discrepancies or problems will be borne by the Contractor.

### 3.02 EQUIPMENT CONNECTIONS

A. Plumbing Contractor Shall:

1. Provide all roughing, and final waste and vent connections to equipment requiring same as called for by the Contract Documents.

2. Refer to the Contract Documents for roughing schedules, equipment and lists indicating scope of connections required.

3. Provide adapters and all necessary piping, fittings, and connections from roughing point to equipment.

### 3.03 ASBESTOS PIPE

A. General: Existing sewer main piping may contain asbestos. Cutting, drilling or other disturbance of this material shall be conducted as specified by New York State Department of Labor, Industrial Code Rule No. 56 "Asbestos". The methods and procedures specified in New York State Department of Labor, Industrial Code Rule No. 56 shall constitute minimum measures and shall in no way relieve the Contractor of sole responsibility for the means, methods, techniques, sequences, or safety measures taken in connection with the work.

### 3.04 TESTING

A. Provide necessary items to complete proper testing of Work.

1. Test all sections of sanitary waste piping installed by this Project. Test existing piping as called for.

2. Maintain 10 feet head of water above highest point of section being tested for a minimum of 15 minutes, or until all joints are inspected and proved tight.

3. For interior piping, leaks of any volume detected in sewers or in floors or walls of appurtenant structures shall be permanently stopped. Should any leaks, defective joints or defective construction be found they shall be promptly made good. Should any defective pipes or specials be discovered they shall be removed and replaced with sound pipes or specials in a satisfactory manner at the Contractor's expense.

4. An air test is not acceptable as a final test.

5. Pay all costs of test.

6. Provide written certification that tests have been conducted and successfully completed. Submit to the within the Owner's Representative and within the O&M manual.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

### 1.02 QUALITY ASSURANCE

A. Follow all requirements, recommendations and appendices of the following publications, codes, standards, and listings:

1. 2020 Fuel Gas Code of New York State (FGCNYS).
2. 2020 Building Code of New York State (BCNYS).
3. American Gas Association (AGA).
4. Local Utility Company: National Fuel Gas Corporation.
5. Local Building Code: Town of Amherst.

### 1.03 SUBMITTALS

A. Provide submittals for all items specified under “Part 2 – Products” of this Section.

B. Submit written certification for natural gas system tests. Submit with O&M Manuals.

## PART 2 - PRODUCTS

### 2.01 SERVICE

A. Existing to remain.

### 2.02 PIPING

A. Interior and Exterior:

1. Refer to Section 220502, "Plumbing Piping Systems and Accessories," for piping materials and requirements.

### 2.03 VALVES

A. Refer to Section 220523, "General Duty Valves for Plumbing Piping" for valve requirements.

## PART 3 - EXECUTION

### 3.01 GAS PIPING

A. Interior, Above Grade:

1. Cap piping where shown on the Contract Drawings.
2. Maximum gas pressure inside building: 1/2 psig (14” w.c.).

### 3.02 GAS PIPING TESTS

A. Provide necessary items to complete proper testing of natural gas piping.

B. Perform tests as required by National Fuel Gas. Tests shall be witnessed by the Owner's Representative.

1. 15 psi air pressure for a minimum of one hour.

2. Tests shall be performed after piping cap installation.

C. Provide written certification that tests have been conducted and satisfactorily completed. Submit within the O&M manuals and to the Owner's Representative.

**END OF SECTION**

## PART 1 - GENERAL

### 1.01 WORK INCLUDED

A. Provide all labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

### 1.02 SUBMITTALS

A. Submit shop drawings for all items specified under “Part 2 - Products" of this Section.

1. Fixture Cuts: Submit shop drawings in folders with cuts of all fixtures, brass trim, and accessories before placing order for fixtures. Provide roughing sheets for all fixtures. Provide dimensions for all fixtures, trim, and accessories.

2. Samples: Submit fixture and accessory samples when requested by Owner and/or Owner’s Representative.

3. Roughing Sheets: Submit roughing sheets in duplicate for each type of fixture when requested.

B. Submit wiring diagrams and manufacturer’s electrical requirements for all electronically operated fixtures and trim.

C. Submit manufacturer’s color charts for cabinet finishes and fixture colors.

D. Submit operations and maintenance information for each fixture. Include this information within the Operations and Maintenance Manual specified in Section 220010.

### 1.03 DESCRIPTION OF FIXTURES

A. All fixtures, trim and fixture accessories shall be similar and equal to the manufacturer’s plate numbers specified in this section. All fixtures and supply trim shall meet the requirements of the New York State Department of Environmental Conservation and shall be listed by that Agency. All exposed parts of fixture trim shall have a polished chrome finish. All tubular drainage products (“P” traps, nipples, etc.) for electric water coolers shall be 17-gauge brass.

B. All fixtures, trim and fixture accessories shall comply with the requirements of ANSI/NSF-61 and ANSI/NSF-372.

C. All fixtures, trim and fixture accessories shall be subject to compliance with the specified requirements and shall be manufactured by the following:

1. Electric Water Coolers: Murdock, Elkay, or Oasis.

2. Fixture Hanger Plate Supports: Murdock, Elkay, or Oasis.

3. Electric Water Cooler Trim: McGuire, Brass-Craft, or Cambridge.

4. Provide the Owner with special wrenches, tools, and devices necessary for servicing plumbing fixtures and trim in a quantity of one device for each 5 (five) fixtures. Provide a minimum of one device if fixture quantity is less than five.

## PART 2 - PRODUCTS

### 2.01 ELECTRIC WATER COOLER (EWC)

A. Tag: EWC-A (Single Level for use by the physically challenged).

1. Building: “K”.

2. Murdock Model #A171408F-UG-VR-BF12-BCD-WF3 lead free, self-contained, heavy duty, vandal resistant, self-closing, single station electric water cooler with refrigerated bottle filling station, two-piece stainless steel basin and backsplash, one-piece vandal resistant bubbler, non-pressurized tank, vandal resistant push-button on front side, refrigerated bottle filling station with electronic sensor activation and 30 second shut-off timer, mounted on wall, 3,000 gallon capacity, 1-micron lead reduction water filter system (NSF 42 & 53 compliant) with a 1.1 gpm fill rate.

a) Fountain Top: 14-gauge, type 302 polished stainless-steel finish.

b) Self-closing, vandal proof, hand operated stops with automatic stream regulator located inside of cabinet.

c) Surfaces and materials in contact with water to be certified lead free per EPA regulations.

d) Compressor: Hermetically sealed, ¼ hp, 120 volts, 60 Hz., single phase.

e) Unit Capacity: 8.0 GPH 80°F water inlet, 50°F water outlet with room temperature at 90°F.

f) Hanger bracket with six (6) pre-punched anchor locations. (Note: Hanger bracket is furnished with fixture).

g) McGuire model #8902 chrome plated, 17 gauge, 1-1/4-inch x 1-1/2-inch "P-trap” with cleanout plug and metal, chrome plated set screw wall escutcheon.

h) McGuire model #167LK, 3/8-inch chrome plated wall supply with loose key angle stops, cast brass set screw escutcheons and 12-inch-long flexible riser.

i) Provide with two (2) replacement water filters for each unit. Turn replacement water filters over to the owner. Provide written confirmation that the owner has received replacement water filters.

j) Provide fixture in compliance with all ADA required clearances and dimensions.

## PART 3 - EXECUTION

### 3.01 FIXTURES, EQUIPMENT AND SYSTEMS

A. Install fixtures, trim, accessories, equipment, and systems as shown on the Drawings or as specified herein in accordance with the provisions of each applicable Section of these Specifications and in compliance with all Federal, State and Local codes having jurisdiction.

### 3.02 FIXTURES

A. Install all fixtures on manufacturer furnished hanger brackets.

B. Install fixtures in accordance with the manufacturer’s written installation instructions.

C. Chromium Plating:

1. All supply and drainage trim and accessories shall have a minimum thickness of 0.002-inch chromium applied over a nickel plating having a minimum thickness of 0.0002 inch.

D. Screws, Bolts and Nuts:

1. All screws, nuts and bolts shall be of size, type, and finish to fit requirements and to harmonize with adjacent material.

2. Nut and bolt heads exposed at fixtures shall be hexagon with bonnet cap and chromium plated brass.

E. Erection:

1. Professionally install fixtures and associated supply and drainage piping and securely support.

2. Carefully drill holes for through-bolts to avoid chipping blocks or plaster where required.

3. Attach fixtures with manufacturer furnished hanger bracket. Attach to walls as follows:

a. Masonry construction:

1) Secure fixture hangers to partition by through-bolts extending through a steel plate on opposite side of partition. Total of six (6) through-bolts.

2) Carefully drill holes to avoid chipping.

3) Obtain Owner's Representative's approval prior to work.

b. Metal stud construction:

1) Anchor backing for fixtures or equipment to 1/8-inch x 12-inch steel plate bolted or riveted to at least three studs. Total of six (6) through-bolts.

2) Obtain Owner's Representative's approval prior to work.

F. Protection: Immediately after installation, thoroughly cover metal trimmings and fixture to prevent damage or scratches. The condition of all fixtures is the responsibility of the Division 22 contractor until the Owner takes final possession of the Project.

G. Cleaning: At completion of Work, clean all fixtures complete with their trimmings; put in working order and in first-class condition and appearance.

H. Installation:

1. Exact mounting height to be determined by the Owner's Representative, Contract Drawings and all ADA requirements.

2. Perimeter of fixtures in contact with the wall shall be caulked with DAP white flexible "Kwik-Seal" tub and tile caulk. Caulk shall be non-shrinking type.

**END OF SECTION**

# PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 23.

B. Section 019113 - Commissioning Requirements

## 1.02 SCOPE OF WORK

A. All portions of the work shown in the construction documents shall be bid by the Mechanical Contractor. Responsibility for performance of subcontractors and trades as lower tier contracts, such as electrical, shall be included as part of the Mechanical Contractor's scope of work.

B. Include in bid all labor, materials, tools, plant, transportation, excavation, equipment, insurance, temporary protection, permits, taxes, services and all necessary and related items required to provide complete and operational systems shown and described.

C. References to codes and standards called for in the Contract Documents mean the latest edition, amendment and revisions to the codes and standards in effect on the date of these Contract Documents.

D. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:

1. Miscellaneous Supports
2. Access Doors and Panels
3. Fire Stopping
4. Cutting and Patching

E. Contract shall include, but not be limited to:

1. HVAC
2. General Contracting work as related to the HVAC Contract
3. Temperature Controls
4. Testing and Balancing of Mechanical Systems

F. Alternates:

1. All work relating to Classroom K162. Designated as Alternate MP-01.

## 1.03 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies having jurisdictional authority. In the event of conflict between these contract documents and the governing rules, regulations, and codes, the most stringent standards shall apply as directed by the Engineer and/or Authorities having jurisdiction.

B. Codes and standards that apply to this project include, but are not limited to:

1. 2020 Building Code of New York State (BCNYS)
2. 2020 Existing Building Code of New York State (EBCNYS)
3. 2020 Energy Conservation Construction Code of New York State (ECCCNYS)
4. 2020 Fire Code of New York State (FCNYS)
5. 2020 Mechanical Code of New York State (MCNYS)
6. ASHRAE Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings.
7. New York State Department of Labor Rules and Regulations.
8. New York State Department of Health Regulations.
9. Federal Occupational Safety and Health Administration (OSHA) Regulations
10. Local Codes and Ordinances for Buffalo, NY & Erie County
11. Factory Mutual and/or Owner's Insurance Carrier
12. New York Board of Fire Underwriters.

## 1.04 LICENSING & PERMITS

A. The Contractor shall hold a license all necessary licenses to perform the scope of work at the project location.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid.

C. Refer to General Conditions of the Contract for additional requirements.

## 1.05 GLOSSARY

| | |
|---|---|
| ADA | Americans with Disabilities Act |
| AGCA | Associated General Contractors of America, Inc. |
| AIA | American Institute of Architects |
| AISC | American Institute of Steel Construction |
| AMCA | Air Moving and Conditioning Association |
| ANSI | American National Standards Institute |
| ARI | Air-Conditioning and Refrigeration Institute |
| ASHRAE | American Society of Heating, Refrigeration and Air-Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing Materials |
| AWSC | American Welding Society Code |
| EIA | Electronic Industries Association |
| FM | Factory Mutual Insurance Company |
| IEEE | Institute of Electrical and Electronics Engineers |
| ISO | International Standards Organization |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers' Association |

| | |
|---|---|
| NESC | National Electrical Safety Code |
| NFPA | National Fire Protection Association |
| NYS/DEC | New York State Department of Environmental Conservation |
| NYS/UFBC | New York State Uniform Fire Prevention and Building Code |
| OSHA | Occupational Safety and Health Administration |
| SMACNA | Sheet Metal and Air Conditioning Contractors National Association |
| UL | Underwriter's Laboratories, Inc. |

**1.06 DEFINITIONS**

| | |
|---|---|
| Approved / Approval | Written permission to use a material or system. |
| As Called For | Materials, equipment including the execution specified/shown in the contract documents. |
| Code Requirements | Minimum requirements. |
| Concealed | Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade. |
| Design Equipment | Refer to the article, BASIS OF DESIGN |
| Design Make | Refer to the article, BASIS OF DESIGN. |
| Equal or Equivalent | Equally acceptable as determined by Owner's Representative |
| Exposed | Work not identified as concealed. |
| Final Acceptance | Owner acceptance of the project from Contractor upon certification by Owner's Representative. |
| Furnish | Supply and deliver to installation location. |
| Furnished by Others | Receive delivery at job site or where called for and install. |
| Inspection | Visual observations by Owner's Site Representative. |
| Install | Mount and connect equipment and associated materials ready for use. |
| Labeled | Refers to classification by a standards agency. |
| Make | Refer to the article, BASIS OF DESIGN. |
| Or Approved Equal | Approved equal or equivalent as determined by Owner's Representative. |
| Owner's Representative | The Prime Professional, Construction Management, or other entity contractually authorized by the Owner for the services referenced. |
| Prime Professional | Architect / Architectural Entity or Engineer / Engineering Entity having a contract directly with the Owner for professional services. |
| Professional Engineer | Individual or Entity licensed to perform Engineering services in the State of New York |
| Provide | Furnish, install and connect ready for use. |
| Relocate | Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use |
| Replace | Remove and provide new item. |
| Review | A general contractual conformance check of specified products. |
| Roughing | Pipe, duct, conduit, equipment layout and installation. |
| Satisfactory | As specified in contract documents. |
| Site Representative | Construction Manager or Owner's Inspector at the work site. |

Refer to General Conditions of the Contract for additional definitions.

## 1.07 BASIS OF DESIGN

A. The contract documents are prepared on the basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Contractor shall provide changes in work of all other trades at no increase in any contract. Provide larger motors, electrical feeders, circuit breakers, equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assumes responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings or floors required to install other than design make equipment. Contractor shall retain the ultimate responsibility for function of equipment and materials which are not the basis of design for the contract documents. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

## 1.08 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.

B. In the event of conflict between the drawings and specifications, or discrepancies within either, this shall be brought to the attention of the Engineer for resolution prior to submission of bids. In the event that the contractor fails to note these discrepancies prior to submission of bids or in writing within their bid submission, the Engineer shall resolve the discrepancy such that the design intent is provided. The contractor shall provide all labor, materials and equipment to correct the installation deficiencies as defined by the Engineer.

## 1.09 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD .dwg or MicroStation ‘dgn’ format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors’ responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors’ coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors’ failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. If the Contractor requests electronic CAD files from the Engineer and this request is granted, the Contractor shall submit application to the Engineer identifying each drawings to process the request.

## 1.010 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size/capacity of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Owner's Representative for resolution.

D. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, cutting and patching.

E. All work shall be done in a neat and workmanlike manner. All methods of construction or details of workmanship, not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and construction indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

F. In the absence of specific information within other sections of this project manual, all work of this project shall be provided with a one year labor and materials warranty against defects in equipment, materials and workmanship, starting from the date of project substantial completion.

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

A. Provide materials that meet the following minimum requirements:

1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.

2. All equipment and material for which there is a listing service shall bear a UL label.

3. Gas-fired equipment and systems shall meet AGA Regulations and shall have an AGA label

4. Electrical equipment and systems shall meet UL Standards and requirements of the NEC. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with UL Standards and the requirements of the NEC.

5. Communications equipment shall meet all FCC Regulations

6. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

7. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

### 2.02 SUBSTITUTIONS

A. The materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted in writing to the Architect and Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material, product or equipment being substituted, cut sheets, installation drawings, performance and test data, warranties and location of three (3) similar installations with reference names of owner or facility personnel responsible for maintaining equipment. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders. Failure to follow the guidelines described above may result in equipment being rejected at submittal based solely on failure to follow the above guidelines.

C. Approval by the Architect and/or Engineer to proceed with a substitution does not relieve the contractor from meeting all of the dimensional requirements and maintaining the full functionality and performance of the material, product or equipment used as the basis of design.

D. Electrical Design Changes Due to Mechanical Substitutions – It shall be the responsibility of all Contractors to transmit all changes of electrical characteristics to the Electrical Contractor which result from any substitutions PRIOR to starting any work. Any and all extra charges by the Electrical Contractor due to these changes are to be paid by the Contractor making the change.

## 2.03 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.

1. All components of an assembled unit need not be products of the same manufacturer.

2. Constituent parts which are alike shall be products of a single manufacturer.

3. Components shall be compatible with each other and with the total assembly for intended service.

4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear the manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

## 2.04 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

## 2.05 SPECIAL TOOLS

A. If any part of equipment requires a special tool for assembly, adjustment or maintenance thereof and such tool is not readily available in the commercial tool market, it shall be furnished by the Contractor as required for the duration of the project and turned over to the Owner in serviceable condition upon completion of the scope of work. Contractor shall obtain written sign off by the Owner certifying that the Owner is in receipt of such tools.

## 2.06 SAFETY GUARDS

A. Provide guards on all shafts and couplings and all V-belt and sheave assemblies to prevent damage to equipment and injury to personnel.

## 2.07 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered without bending or distortion of shape, such as rapid lowering and braking of load.

## 2.08 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:

1. Steel plates, shapes, bars, and grating - ASTM A 36
2. Cold-Formed Steel Tubing - ASTM A 500
3. Hot - Rolled Steel Tubing - ASTM A 501
4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal fasteners shall be zinc-coated (type, grade and class as required).

## 2.09 ACCESS DOORS AND PANELS

A. Steel access doors and frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Provide access doors at all locations where equipment access for service, repair, and/or adjustment may be required. This shall include access to all air balance dampers. (In lieu of access to air balance dampers above hard ceilings or in chase walls, Contractor may submit for approval for use of remote regulators.)

C. Construction:

1. Frames:

a) 16 gage steel with 1 inch wide, exposed, perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast-in-place concrete, or ceramic tile.

b) 16 gage steel, perforated flanges with bead for gypsum or plaster wall board.

c) 16 gage steel with galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.

2. Access Doors:

a) Provide 14 gage sheet steel, flush panel doors with concealed, continuous, factory-installed piano hinge, primed and painted, set to open 175 degrees in unrated partitions.

b) Provide fire-rated, insulated, flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1-½ hour “B” labeled, in fire-rated partitions.

3. Provide flush, screwdriver operated cam locks on all access doors.

4. Access doors shall be gasketed type where installed in rooms or spaces required to maintain a positive or negative pressure requirement to adjacent rooms or spaces.

### 2.010 FIRE STOPPING

A. Fire-stopping for openings through fire and / or smoke rated walls and floor assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated by ASTM E814.

B. Submit for approval all fire stop systems and materials for approval by the Engineer

C. Acceptable Manufacturers:

1. Hilti Firestop Systems

2. Dow Corning Fire-Stop System Foams and Sealants.

3. Nelson Electric Fire-Stop System Putty, CLK and WRP.

4. Thomas & Betts - S-100 FS500/600,

5. Carborundum Fyre Putty.

## PART 3 - EXECUTION

### 3.01 SUBMITTALS: SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Incomplete submittals will not be accepted. All products specified in an individual Division 23 Section shall be submitted at the same time. Number each submittal. Indicate deviations from contract requirements on Letter of Transmittal. Corrections or comments made on the Shop Drawings during the review do not relieve the Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

B. Approval of shop drawings will not relieve this contractor from responsibility for deviations from the contract documents. It is the responsibility of the Contractor to meet the requirements of these documents. All errors or omissions in the product data are to be corrected by this contractor irrespective of any approvals by the Architect or Engineer.

C. Pre-test submittals must be written in report format, submitted and signed off on by the Engineer prior to the start of any construction work, including demolition.

D. Shop drawings include, but are not limited to, the submissions listed below. Refer to individual specification sections for specific requirements and additional submission requirements.

| SECTION | DESCRIPTION | REQUIRED SUBMISSIONS |
|---|---|---|
| 230010 | Basic Mechanical Requirements | Access doors<br>Fire Stopping<br>Special requirements related to substitutions<br>Sheet metal shop / coordination drawings<br>Operation and Maintenance Manuals<br>Record Documents / Drawings |
| 230509 | Roof Curbs | Typical detail and schedule for equipment. Details shall include cross-sectional view illustrating clearly the type of curb being submitted, i.e. double wall insulated, with or without cant. |
| 230513 | Motors | Motor info with equipment submittal for equipment served. |
| 230514 | Electric Wiring | Complete wiring diagram for equipment and systems. |
| 230523 | Valves | Valves and accessories |
| 230550 | Wind Restraints for HVAC Systems. | Manufactures technical product data for wind restraint systems. Provide professional engineer stamped and signed calculations, and details of wind restraint systems to meet total design lateral force requirements for support and restraint of mechanical and electrical systems. |
| 230553 | Mechanical Identification | Manufactures technical product data and installation instructions for each identification material and device.<br>Valve schedule for each piping system typewritten on an 8-1/2. X 11 in. (minimum) indicating code number, location and valve function.<br>Schedule of pipe, equipment and name identification for review before stenciling or labeling. Confirm naming/numbering is consistent with Owner's convention. |
| 230593 | Testing, Adjusting and Balancing | Quality-Assurance Submittals<br>Sample Report Forms<br>Report of plan review for balancing devices necessary to achieve proper system balance but not specified<br>Certified Testing, Adjusting, and Balancing Reports (including any specified pre-testing of systems)<br>Warranty Documentation |
| 230700 | Insulation | Manufacturer data. Schedule of insulation applications. Certifications to demonstrate compliance specifications and governing regulations, including proof of compliance for test of products for fire rating, corrosiveness, and compressive strength. |
| 230923 | Temperature Controls | Control System Submittal<br>Pre-Commissioning Report<br>As-Built documentation and drawings<br>Operations and Maintenance Manuals / Closeout Documentation<br>Training Agenda and Documentation<br>Warranty |
| 232000 | Piping Systems and Accessories | Schedule of pipe materials, fittings, connections and accessories by piping system. |

| | | |
|---|---|---|
| 232133 | Water Systems Specialties | Shop drawings on water system specialties |
| 233000 | Sheet Metal and Ductwork Accessories | Shop drawings of all sheet metal equipment being provided. Submit a complete shop standard manual including construction details for all shop fabricated materials.<br>Ductwork Detail Drawings.<br>Exhaust and kitchen hood details. |
| 233316 | Fire Dampers | Types, schedule of sizes, locations, and installation arrangements of all dampers.<br>Manufacturers UL listed installation details for each mounting arrangement. |
| 233400 | Fans | Shop drawings on fans, motors, drives, and accessories. Include all fan curves and fan operating point. |
| 233713 | Registers | Registers/Grilles/Diffusers.<br>Room schedule listing size, throw, direction of throw, accessories, finish, material type and color chart. |
| 233726 | Louvers | Louvers including all blade types, finishes and arrangements.<br>Penthouses including materials, finishes and accessories.<br>Provide original color charts for selection of finish |
| 238210 | Hydronic Gravity Heating Equipment | Shop drawings on gravity heating equipment with color selection chart. Clearly indicate which equipment is being submitted. |
| 238223 | Unit Ventilators | Unit ventilators and accessories including heating and cooling coil capacities, inlet and outlet types. Color chart. One (1) mockup installation including pipe enclosure, wall sleeve, louver and components. |

**3.02 COORDINATION DRAWINGS**

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings in the form of color coded electronic files (dwg or rvt) not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as follows:

1. Division 23 shall prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be AutoCAD format of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, light fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Re-position proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc. Provide these adjustments as part of Base Bid Contracts.

2. Coordination drawings to include positioning of fire, smoke and combination damper assemblies, associated actuators and access / inspection doors and shall consider ceiling construction in final positioning based on ceiling type on either side of partition or barrier for optimum result.

3. Division 23 will provide AutoCAD files and prints and submit the base plan to all major trades' Contractors.

4. Division 26 (Electrical), and Division 21 (Fire Protection) will each draft location of piping, conduits, equipment, etc. on the base plan as provided by Division 23 such that a complete coordination of all trades is represented and areas of conflict and recommended resolutions are noted.

5. Do not install any equipment, equipment foundations, ductwork, or piping until Coordination Drawings have been approved. Failure to receive approval prior to installation of the aforementioned items, will put the risk on the contractor to remove and reinstall at the engineer's discretion. Additional time spent by the engineer in the field reviewing construction progress due to not receiving ductwork shop drawings and coordination drawings prior, will be considered an additional service by the consultant, which shall be paid by the contractor and deducted from any moneys owed to the contractor. The consultant's hourly rate will apply.

## 3.03 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature(s) required to provide safe conditions for all workmen and site visitors.

## 3.04 EXISTING SYSTEMS AND CONDITIONS

A. Existing conditions are taken from field observations and prior construction documents and are not guaranteed. The contractor shall field verify all existing conditions. No allowance will be made for additional costs due to Contractors failure to verify existing conditions.

B. Prior to beginning work, inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented and submitted, the Contractor shall repair all damage found at the completion of the project that is determined to have been caused by the work of this contract. Repairs shall restore the area to like new condition.

C. The Owner's Representative shall determine if the Contractor has damaged existing systems or construction and shall approve the repairs.

## 3.05 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The Contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the Owner's asbestos management plan. Prior to performing such work, identify areas containing asbestos. Notify the Owner so that arrangements may be made for abatement and/or containment prior to work proceeding. The Contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 Sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Refer to Division 2 sections for further requirements.

## 3.06 REMOVALS

A. Demolition of mechanical systems will include removal and deprogramming of multiple control system devices and sensors. Coordinate with Owner for quantity and type of devices which they desire to retain. Remove all components in good condition and turn over to the Owner's representative.

B. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that the Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by the Owner. Items that the Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, each crawl space and each roof to determine total Scope of Work. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation, conduit, panels, and all hangers, including the top connection and any fastenings to building structural systems. Where pipe and ductwork is removed and no new connections are planned or shown, cap, seal and insulate the pipe and ductwork which remains. Seal all openings, after removal of equipment, pipes, ducts, conduits and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

D. The shutting down of the existing HVAC systems shall be properly coordinated with the Owner. Provide the necessary personnel in shutting down the systems as necessary to facilitate the intended work. Water and glycol systems shall be fully drained prior to any removals. The Contractor shall propose to the Owner the points of isolation of the system to minimize the duration of the shutdown for draining, performing the necessary work and refilling of the system. Systems containing a glycol solution shall be drained in a manner to collect the solution in containers for storage or disposal. Glycol solution not utilized for refilling the systems upon completion of work shall be removed from the site and properly disposed of in a legal manner by the Contractor. Upon completion of removals and new work, the Contractor shall refill and vent the systems to return the systems back to their original operation condition.

## 3.07 STORAGE AND PROTECTION OF MATERIALS

A. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

B. Refer to "General Conditions of the Contract for Construction."

## 3.08 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building. Perform first seasons winterizing in presence of Owner's operating staff.

### 3.09 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the Owner's Representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owner's Representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the Contractor at no expense to the Owner.

3. For equipment and connections provided in this contract, prepare roughing drawings as follows:

   a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.

   b. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.

4. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and manufacturer's recommended service clearances to allow for required maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

D. All equipment requiring service and / or access shall be provided adequate clearances for this purpose. Any clearances described in manufacturer's information, code requirements, etc., shall be taken into account in determining final rough-in positions. Reasonable access for maintenance and service shall be maintained.

E. Under no circumstances shall clearance be reduced from the MCNYS requirements for 30" x 30" level workspace in front of the control side of any appliance.

F. The most stringent standard, as determined by the Engineer, shall apply.

**3.010 CUTTING AND PATCHING**

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch all abandoned penetrations left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

**3.011 CONCEALMENT**

A. **Conceal all contract work** above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

**3.012 CHASES**

A. In Existing Buildings:

1. Drill holes for floor and/or roof slab openings.

2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.

3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2" above floors.

4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

**3.013 ACCESS DOORS AND PANELS**

A. Provide access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, duct mounted fire alarm detectors and other electrical equipment requiring access for maintenance or operation.

B. Provide access doors, sized to permit compete access for all items requiring adjustment, such as balance dampers above solid ceilings.

C. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

E. Access doors and panels shall operate freely and be fully usable for their intended function.

**3.014 FIRE-STOPPING**

A. Fire-stopping for openings through fire and smoke rated wall and floor assemblies:

1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire-rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.

3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

4. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.

6. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

**3.015 FLASHING AND SEALING**

A. Openings through roofs shall be flashed in a manner to not affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of the contract. Provide non-ferrous flashing pieces, skirts, hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Where openings for pipe/duct penetrate through roofs into equipment pipe chases, mechanical spaces or penthouses, the penetration of the roof deck/slab shall be sleeved, sealed and firestopped as required. Insulate at base of pipe chase, mechanical space or penthouse to match insulation value of the roofing system.

C. Apply all flashing and sealers within the temperature and humidity limits permitted by the manufacturer.

**3.016 SUPPORTS**

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support mechanical/electrical work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

## 3.017 GENERAL INSTALLATIONS REQUIREMENTS

A. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed

B. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.

C. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

D. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

E. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

F. No equipment shall be hidden or covered up prior to inspection by the Owner's Representative. All work requiring inspection which is concealed prior to approval shall be re-opened for inspection at the Contractor's expense. All work that is determined to be unsatisfactory shall be corrected immediately.

G. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

H. Install access panels or doors where units are concealed behind finished surfaces.

## 3.018 ADDITIONAL ENGINEERING SERVICES

A. In the event the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

B. In the event the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

C. In the event the Consultant is required to initiate design changes due to failure of the contractor to properly coordinate with the construction schedule, and / or other trades, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owned to the Contractor.

### 3.019 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:

1. Thoroughly clean entire installation, both exposed surfaces and interiors.

2. Remove all debris caused by work.

3. Remove tools, surplus, materials, when work is finally accepted.

B. Cleanliness of construction shall extend to include the interior and exterior surfaces of all equipment and systems provided under this contract. This includes, but is not limited to:

1. Unitary equipment exposed to occupant use (cabinet heaters, baseboard systems, etc.) Shall be thoroughly cleaned for final use both inside and out prior to project completion.

2. Equipment located in mechanical spaces shall be cleaned on the exterior such that no significant accumulation of debris or dirt is evident.

3. Interiors of all air handling equipment (rooftop systems, air handlers, etc.) shall be thoroughly cleaned on the interior such that no evidence of dust, dirt or debris remains prior to project turnover.

4. Ductwork systems – Ductwork shall be delivered to the job site with ends capped or covered to eliminate contamination during transportation and site storage. All open ends shall remain covered during the entire course of the construction process. Ductwork with evidence of dust, dirt or debris shall be thoroughly cleaned by an approved method prior project turnover.

### 3.020 HVAC EQUIPMENT CONNECTIONS

A. Provide final steam, condensate, hot water, glycol, chilled and condenser water, drain, vent, oil line and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and rail connections extended to floor drains.

B. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.

C. Refer to manufacturer’s drawings and specifications for requirements of medical equipment, laboratory equipment and special equipment. Verify connection requirements before bidding and confirm prior to roughing.

### 3.021 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical facilities or services.

### 3.022 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owner's designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed. Prior to acceptance repeat the instructions. If asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer's certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e. adjustable speed drive and air handling unit) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up, including problems that occurred and their method of resolution.

C. Refer to Section 017700 – Closeout Procedures for additional requirements.

### 3.023 OPERATION AND MAINTENANCE MANUALS

A. In addition to requirements stated elsewhere in these specifications, provide Operating and Maintenance manual(s) which include the following:

1. Approved Submittal documentation for all equipment stating size and selected options for each piece of equipment requiring maintenance.

2. Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance (excepting equipment not furnished as part of this project). Routine maintenance actions shall be clearly identified. The data shall include internal wiring diagrams and spare parts lists.

3. Name and address of each equipment supplier and at least one service agency for each piece of equipment.

4. HVAC and service water controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings and at control devices or, for digital control systems, in programming instructions.

5. A narrative of how each system is intended to operate, including recommended setpoints. Include emergency operating instructions, seasonal changeover, freeze protection and precautions necessary for Owner operations of systems.

6. As-built drawings for the project (see Record Documents) and piping diagrams.

B. Bind above items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance. Provide copy of O&M Manual in electronic format on CD or other media format acceptable to the Owner. All documents shall be in PDF format, with the exception of record drawings which shall be provided in AutoCAD compatible drawing format.

### 3.024 RECORD DOCUMENTS

A. In addition to all requirements elsewhere in the Contract Documents, prepare and provide record documents of the as-constructed work which meets the following minimum standards:

1. Utilities below floors, slabs and grade: During construction, maintain accurate records of all final locations and inverts for all services inside and outside of the buildings, beneath grade and below floors.

2. Ductwork and Piping:

a. All ductwork and piping shall be clearly dimensioned with its outside dimensions (diameter or length X width) at each unique section/piece.

b. Elevations of all ductwork and piping shall be clearly identified. Elevation should be taken in respect to the finish floor and bottom of ductwork or pipe.

c. X/Y dimensions should be included for all ductwork and piping to provide precise location from a fixed bench-mark such as the corner of a building, column, etc., and neatly and clearly indicate same on reproducible prints.

3. Provide Record Drawings for all Contract Work. Document the location of control devices isolation valves, safety devices and equipment.

4. Incorporate all field changes, change orders and other modifications into the final Record Drawings.

5. Record drawings shall contain all corrections from construction documents to as-built conditions and shall be submitted for review and approval.

6. Drawing format:

a. Documents shall be provided in PDF formant or, where fully developed in CAD, in AutoCAD compatible file format. Submittal media shall be as acceptable to the Owner and Engineer

b. Drawings scale shall not be less than 3/8" = 1'-0".

c. Marked up PDFs of the contract documents will not be acceptable

### 3.025 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre-designated site.

B. HVAC items normally accepted as salvage by the Owner:

1. Temperature control and automation hardware.

END OF SECTION

# PART 1 - GENERAL

## 1.01 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation of roof curbs, as shown in the Contract Documents. This section applies to equipment used to support mechanical system components and is inclusive of curbs, equipment supports, support stands and penetration housings.

## 1.02 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all requirements therein.

B. This contractor shall coordinate all final rail selections, including anchoring details to both equipment and building roof deck, with the requirements of specification Section 230550 (Wind Restraint for HVAC Systems). Final determinations as provided by the Engineer of Record for the seismic and/or wind restraint calculations shall override any similar information provided within these specifications and the project drawings.

## 1.03 SUBMITTALS

A. Typical detail and schedule for equipment used to support mechanical system components shall include cross-sectional view illustrating clearly the type of curb being submitted, i.e. double wall insulated, with or without cant.

# PART 2 – PRODUCTS

## 2.01 ROOF CURBS

A. Curb constructed of galvanized steel, with continuous welded corner seams and painted at all welds. 20 gauge up to 36"., 18 gauge 38 to 72"., 16 gauge over 72" in any dimension. Double wall with liner and 1-1/2" minimum thickness 3# density fiberglass insulation. All fans to have minimum 24" high curbs. Provide curb with gasket on top to make airtight seal between curb and ventilator, fan, or air handling unit. Curb provided with raised cant, flanged or recessed to coordinate with roofing type. Curb flange shall suit roof construction, wind restraint requirements, and type of insulation being applied.

B. Design Equipment: RPS Model RC Series.

C. Acceptable Make: Pate, Shipman & Son, RPS.

# PART 3 - EXECUTION

## 3.01 GENERAL

A. Height as recommended by equipment manufacturer, not less than described in Part 2.0. This Contractor shall be responsible for exact size, length, and location and shall set and secure each curb to roof. Shim and level curb as required. Provide curb and supports for all roof-mounted equipment. All roof penetrations shall be made through an appropriate curb. All roof-mounted equipment including fans, etc., shall be set on an equipment support unless otherwise noted. Refer to Contract Drawings for details on plenums extending from curbs.

# END OF SECTION

# PART 1 – GENERAL

## 1.01 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

## 1.02 SUBMITTALS

A. Submit motor information with submittal for equipment served, when applicable. Motor submittal shall include manufacturer's name and model number, motor type, motor characteristics including voltage, phase, horsepower, and speed.

# PART 2 – PRODUCTS

## 2.01 MOTORS

A. General Requirements:

1. Motors built for 60 Hz operation, three phase for 1/2 hp and larger; single phase for 1/3 hp and smaller. In compliance with NEMA Standards, wound specifically for nameplate voltage, and selected for appropriate duty and environment. Minimum service factor of 1.15 at rated voltage and frequency. Bearings ABMA L10 rated for 5 years continuous, non-severe duty. V-belt connected motors with adjustable slide rail bases and pulleys. Motors shall have Class F insulation system, with Class B temperature rise. Maximum allowable motor temperature rise for open drip-proof or totally enclosed fan cooled (TEFC) type at 1.15 service factor shall be 80$^{o}$C above 40$^{o}$C ambient up to 300 hp. NEMA locked rotor KVA code as required to match unit equipment torque characteristics. Single-phase motors shall be capacitor start, induction run, or split phase type. Polyphase motors shall be constant speed, squirrel cage, unless otherwise called for. Motors for solid state driven, variable speed fans or AHU units shall be designed for definite purpose energy efficient drive control.

2. Fractional HP Fan Motors between 1/12 and 1 hp shall be electronically commutated motors or have a minimum motor efficiency of 70%, rated in accordance with DOE 10 CFR 431. Motors shall be provided with motor speed adjustment for balancing and / or remote control as may be required by the sequences of operation. The use of belt driven fans to sheave adjustments for air flow balancing in lieu of varying motor speed is permitted.

    a) Exceptions:

        (1) Motors in the air stream of fan coils and terminal units that only provide heating to the space served.

        (2) Motors in systems which meet the efficiency ratings in part 403 of the IECC while accounting for motor power in the efficiency calculations.

3. Three Phase Motors rated 1 hp and greater shall meet the following nominal efficiency ratings:

    a) Minimum Nominal Full-Load Efficiency for 60 Hz NEMA General Purpose Electric Motors (Subtype I) rated 600 Volts or less (Random Wound)

| Motor Horsepower | Number of Poles | Open Drip Proof Motors | | | Totally Enclosed Fan Cooled Motors | | |
|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 2 | 4 | 6 |
| | Synchronous Speed (RPM) | 3600 | 1800 | 1200 | 3600 | 1800 | 1200 |
| 1 | | 77.0 | 85.5 | 82.5 | 77.0 | 85.5 | 82.5 |
| 1.5 | | 84.0 | 86.5 | 86.5 | 84.0 | 86.5 | 87.5 |
| 2 | | 85.5 | 86.5 | 87.5 | 85.5 | 86.5 | 88.5 |
| 3 | | 85.5 | 89.5 | 88.5 | 86.5 | 89.5 | 89.5 |
| 5 | | 86.5 | 89.5 | 89.5 | 88.5 | 89.5 | 89.5 |
| 7.5 | | 88.5 | 91.0 | 90.2 | 89.5 | 91.7 | 91.0 |
| 10 | | 89.5 | 91.7 | 91.7 | 90.2 | 91.7 | 91.0 |
| 15 | | 90.2 | 93.0 | 91.7 | 91.0 | 92.4 | 91.7 |
| 20 | | 91.0 | 93.0 | 92.4 | 91.0 | 93.0 | 91.7 |
| 25 | | 91.7 | 93.6 | 93.0 | 91.7 | 93.6 | 93.0 |
| 30 | | 91.7 | 94.1 | 93.6 | 91.7 | 93.6 | 93.0 |
| 40 | | 92.4 | 94.1 | 94.1 | 92.4 | 94.1 | 94.1 |
| 50 | | 93.0 | 94.5 | 94.1 | 93.0 | 94.5 | 94.1 |
| 60 | | 93.6 | 95.0 | 94.5 | 93.6 | 95.0 | 94.5 |
| 75 | | 93.6 | 95.0 | 94.5 | 93.6 | 95.4 | 94.5 |
| 100 | | 93.6 | 95.4 | 95.0 | 94.1 | 95.4 | 95.0 |
| 125 | | 94.1 | 95.4 | 95.0 | 95.0 | 95.4 | 95.0 |
| 150 | | 94.1 | 95.8 | 95.4 | 95.0 | 95.8 | 95.8 |
| 200 | | 95.0 | 95.8 | 95.4 | 95.4 | 96.2 | 95.8 |
| 250 | | 95.0 | 95.8 | 95.4 | 95.8 | 96.2 | 95.8 |
| 300 | | 95.4 | 95.8 | 95.4 | 95.8 | 96.2 | 95.8 |
| 350 | | 95.4 | 95.8 | 95.4 | 95.8 | 96.2 | 95.8 |
| 400 | | 95.8 | 95.8 | 95.8 | 95.8 | 96.2 | 95.8 |
| 450 | | 95.8 | 96.2 | 96.2 | 95.8 | 96.2 | 95.8 |
| 500 | | 95.8 | 96.2 | 96.2 | 95.8 | 96.2 | 95.8 |

Note: Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

b) Minimum Average Full Load Efficiency Polyphase Small Electric Motors:

| Motor Horsepower | Open Motors | | | |
|---|---|---|---|---|
| | Number of Poles | 2 | 4 | 6 |
| | Synchronous Speed (RPM) | 3600 | 1800 | 1200 |
| 0.25 | | 65.6 | 69.5 | 67.5 |
| 0.33 | | 69.5 | 73.4 | 71.4 |
| 0.50 | | 73.4 | 78.2 | 75.3 |
| 0.75 | | 76.8 | 81.1 | 81.7 |
| 1 | | 77.0 | 83.5 | 83.8 |
| 1.5 | | 84.0 | 86.5 | 83.8 |
| 2 | | 85.5 | 86.5 | N/A |
| 3 | | 85.5 | 86.9 | N/A |

c) Minimum Average Full Load Efficiency for Capacitor-Start Capacitor-Run and Capacitor-Start Induction-run Small Electrical Motors

| Motor Horsepower | Open Motors | | | |
|---|---|---|---|---|
| | Number of Poles | 2 | 4 | 6 |
| | Synchronous Speed (RPM) | 3600 | 1800 | 1200 |
| 0.25 | | 66.6 | 68.5 | 62.2 |
| 0.33 | | 70.5 | 72.4 | 66.6 |
| 0.50 | | 72.4 | 76.2 | 76.2 |
| 0.75 | | 76.2 | 81.8 | 80.2 |
| 1 | | 80.4 | 82.6 | 81.1 |
| 1.5 | | 81.5 | 83.8 | N/A |
| 2 | | 82.9 | 84.5 | N/A |
| 3 | | 84.1 | N/A | N/A |

d) Minimum Nominal Full-Load Efficiency of General Purpose Electric Motors (Subtype II) and all Design B Motors Greater than 200 Horsepower

| Motor Horsepower | Number of Poles | Open Drip Proof Motors | | | | Totally Enclosed Fan Cooled Motors | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 | 2 | 4 | 6 | 8 |
| | Synchronous Speed (RPM) | 3600 | 1800 | 1200 | 900 | 3600 | 1800 | 1200 | 900 |
| 1 | | NR | 82.5 | 80.0 | 74.0 | 75.5 | 82.5 | 80.0 | 74.0 |
| 1.5 | | 82.5 | 84.0 | 84.0 | 75.5 | 82.5 | 84.0 | 85.5 | 77.0 |
| 2 | | 84.0 | 94.0 | 85.5 | 85.5 | 84.0 | 84.0 | 86.5 | 82.5 |
| 3 | | 84.0 | 86.5 | 86.5 | 86.5 | 85.5 | 87.5 | 87.5 | 84.0 |
| 5 | | 85.5 | 87.5 | 87.5 | 87.5 | 87.5 | 87.5 | 87.5 | 84.0 |
| 7.5 | | 87.5 | 88.5 | 88.5 | 88.5 | 88.5 | 89.5 | 89.5 | 85.5 |
| 10 | | 88.5 | 89.5 | 90.2 | 89.5 | 89.5 | 89.5 | 89.5 | 88.5 |
| 15 | | 89.5 | 91.0 | 90.2 | 89.5 | 90.2 | 91.0 | 90.2 | 88.5 |
| 20 | | 90.2 | 91.0 | 91.0 | 90.2 | 90.2 | 91.0 | 90.2 | 89.5 |
| 25 | | 91.0 | 91.7 | 91.7 | 90.2 | 91.0 | 92.4 | 91.7 | 89.5 |
| 30 | | 91.0 | 92.4 | 9.4 | 91.0 | 91.0 | 92.4 | 91.7 | 91.0 |
| 40 | | 91.7 | 93.0 | 93.0 | 91.0 | 91.7 | 93.0 | 93.0 | 91.0 |
| 50 | | 92.4 | 93.0 | 93.0 | 91.7 | 92.4 | 93.0 | 93.0 | 91.7 |
| 60 | | 93.0 | 93.6 | 93.6 | 92.4 | 93.0 | 93.6 | 93.6 | 91.7 |
| 75 | | 93.0 | 94.1 | 93.6 | 93.6 | 93.0 | 94.1 | 93.6 | 93.0 |
| 100 | | 93.0 | 94.1 | 94.1 | 93.6 | 93.6 | 94.5 | 94.1 | 93.0 |
| 125 | | 93.6 | 94.5 | 94.1 | 93.6 | 94.5 | 94.5 | 94.1 | 93.6 |
| 150 | | 93.6 | 95.0 | 94.5 | 93.6 | 94.5 | 95.0 | 95.0 | 93.6 |
| 200 | | 94.5 | 95.0 | 94.5 | 93.6 | 95.0 | 95.0 | 95.0 | 94.1 |
| 250 | | 94.5 | 95.4 | 95.4 | 94.5 | 95.4 | 95.0 | 95.0 | 94.5 |
| 300 | | 95.0 | 95.4 | 95.4 | NR | 95.4 | 95.4 | 95.0 | NR |
| 350 | | 95.0 | 95.4 | 95.4 | NR | 95.4 | 95.4 | 95.0 | NR |
| 400 | | 95.4 | 95.4 | NR | NR | 95.4 | 95.4 | NR | NR |
| 450 | | 95.8 | 95.8 | NR | NR | 95.4 | 95.4 | NR | NR |
| 500 | | 95.8 | 95.8 | NR | NR | 95.4 | 95.8 | NR | NR |

Note: Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

4. Nominal Motor Voltage Table:

| Nominal System Voltage | Motor Nameplate |
|---|---|
| 480V - 3 phase | 460 volt |
| 240V - 1 phase and 3 phase | 230 volt |
| 208V - 1 phase and 3 phase | 200 volt |
| 120V - 1 phase | 115 volt |

5. Motor Application:

| Environment/Location | Motor Enclosure Type |
|---|---|
| General Purpose | Open drip-proof, TEFC, or encapsulated |
| Outdoors, below grade or high humidity | TEFC |
| Hazardous | Explosion-proof |
| Packaged Refrigeration Compressors | Hermetic or semi-hermetic |

6. Make: Need not be all of same make, but one of the following: General Electric, Gould, Reliance, Westinghouse, Marathon, Baldor or equal.

## PART 3 – EXECUTION

### 3.01 MOTORS

A. Furnished by equipment manufacturer and especially manufactured and/or selected, mounted, and installed for intended use. Install motors accessible for maintenance and belt adjustment.

### 3.02 REPLACEMENT OF EXISTING MOTORS

A. Field verify existing motor characteristics and provide motors as called for. Modify or replace existing motor mounts and bases to accommodate the replacement motors. Replace drive and driven sheaves and provide a heavy duty belt set.

## END OF SECTION

# PART 1 – GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services for the complete installation of motor control, equipment manufacturer remote device and temperature control wiring as required for a fully functional system. Provide interlock wiring from safety devices (freezestats, flow switches, etc.) to control panels. Provide wiring and conduit required to connect devices furnished as part of or adjunctive to the automatic temperature control system and for motor control regardless of the source of supply. Control wiring includes 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 120 volt maximum. Provide devices required for proper system operation, including special electrical switches, transformers, disconnect switches, relays, and circuit breaker protection.

B. Coordinate all work with Division 26, "Electrical".

## 1.02 RELATED SECTIONS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all requirements therein.

B. This Section applies to all work provided under division 23.

## 1.03 WORK NOT INCLUDED

A. Power wiring for motors, motor starters and associated starting and control equipment, as well as the motor starters (except in the case of equipment specified to have packaged controls/starters), are included in Division 26, "Electrical," unless otherwise called for.

## 1.04 QUALIFICATIONS

A. Wiring installed in compliance with all requirements of Division 26, "Electrical" and the National Electric Code.

## 1.05 SUBMITTALS

A. Provide submittals including complete wiring diagrams for equipment and systems. Deliver wiring diagrams to proper trades in time for roughing of conduit, equipment connections, and to avoid delay in construction schedule. Wiring diagrams and roughing information shall clearly indicate scope of work that is part of the Work of Division 26, "Electrical".

# PART 2 – PRODUCTS

## 2.01 PRODUCTS

A. Refer to Division 26 specifications for required wiring materials.

B. All wiring system materials within plenums shall be non-combustible or shall be listed and labeled as having a flame spread index not more than 25 and a smoke developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723. These requirements include control system components and all associated components. All electrical and control components not conforming to these requirements must be fully contained in a non-combustible enclosure or raceway unless listed and labeled for such use under UL 2043.

C. Combustible electrical wires and cables and fiber-optic cables exposed within a plenum shall be listed as having a peak maximum optical density of 0.50 or less and an average optical density of 0.15 or less, and a maximum flame spread distance of 5 ft. or less when tested in accordance with NFPA 262 or shall be installed in metal raceways or sheathed cable. Combustible optical fiber and communication raceways exposed within a plenum shall be listed to the same maximum and average optical densities and flame spread distance under ANSI/UL 2024. Only plenum rated wires and cables shall be installed in plenum rated raceways.

## PART 3 – EXECUTION

### 3.01 GENERAL

A. Check electrical wiring pertaining to equipment for completeness and correctness of connections. Correct any misapplied motor and/or motor starter, improper thermal overload device, or device which fails to function and resultant damage, whether due to incorrect connections or improper information on wiring diagrams.

B. All wiring which passes through an enclosure, wall stud, framing, or other material where abrasion to the wiring system is a long term risk shall be protected using bushing inserts. Electrical tape or other removal media is not considered proper protection against abrasion.

C. Final connections to equipment shall be provided with using flexible whips no longer than 18 inches in length terminated using appropriate connectors.

D. Conduits mounted directly to the outside of insulated plenums, equipment or ductwork shall be installed using appropriate standoff's to avoid compressing the insulation and reducing the value. Repair all insulation damaged during conduit and wiring system installation.

E. Wiring shall be appropriately trimmed and terminated at all equipment. Bundled excess wiring "loops" will not be permitted.

### 3.02 WIRING FOR CONTROL SYSTEMS

A. Provide motor control, temperature control, interlock, safety device and instrumentation wiring for equipment. All wiring shall be in conduit, unless otherwise noted. Refer to Division 26 for type of conduit to be used in specific applications. Provide 18 in. long flexible conduit at motors and devices subject to vibration. Conduit shall be supported on 5 ft. centers. Do not attach directly to hot surfaces, piping, or ductwork. Control wiring shall be in separate conduit from all other wiring. Provide green grounding wire circuited from starter, and run ground wire through conduit to each remote auxiliary relay, pushbutton station, remote panel heating device, thermostat, or device with potentials in excess of 50 volts. Size ground wire as required by NEC.

B. Provide pushbutton stations, pilot lights, selector switches, auxiliary starter contacts, and other devices required to provide specified functions.

C. Where allowable by Code and contract documents, temperature control wiring may be installed without conduit. Installation and wire insulation types shall be as described by NEC, Article 725. All low voltage wiring circuits 50V and under shall:

1. When installed horizontally above accessible ceilings low voltage wiring may be run without conduit. Cables shall be supported using bridle rings attached to building structure. Wherever possible, wiring shall be bundled to avoid clutter in the ceiling cavity, and wiring runs shall be provided parallel and perpendicular to building lines.

2. All exposed wiring in occupied spaces shall be run in surface metal raceway, wiremold v700 series where no access is available to wall cavity.

3. In locations where control wiring is being run to wall mounted sensors, the conduit within the stud wall, as well as the junction box, shall be of non-metallic construction. Carlon Flex-Plus Blue Electrical Non-metallic Tubing and Accessories, or equal.

4. All cases not specifically covered by the above cases shall be run in conduit.

### 3.03 EQUIPMENT WIRING

A. Provide power and control wiring between sections of electric radiation units, between shipping splits, and between remote panels, thermostats, disconnect switches, and their respective units. Provide control wiring from the package control system, to each respective electric heat coil, reheat coil or motor. Properly mount control package. Power wiring to and including disconnect switch shall be by Division 26 "Electrical".

### 3.04 FIELD WIRING IN STARTERS, CONTROLLERS, AND PANELS

A. Wiring within starters, controllers, and temperature control panels, shall be routed neatly in gutter space, away from moving and/or heat producing parts. Provide 30 ampere, 600 volt rated terminal blocks. Do not place more than two wire connections on pilot device or relay terminal. Where more than two circuit connections are required, use terminal blocks. Provide nylon self-insulated, locking type spade lugs for all control wires. Cables and wires shall be neatly bundled and lashed with nylon cable straps. All wiring installed in a single enclosure shall be rated for the maximum voltage in said enclosure or physical separation provided in compliance with the NEC.

## END OF SECTION

# PART 1 – GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment, and services as required for the complete installation and related work designated in contract documents.

## 1.02 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

## 1.03 SUBMITTALS

A. Valves and accessories.

# PART 2 – PRODUCTS

## 2.01 VALVES:

A. General: Valves shall meet the following requirements:

1. Working pressure shall be stamped or cast on bodies.

2. Stem packing shall be serviceable without removing valve from line.

3. To establish a standard of quality and identify features, certain manufacturer's numbers are given in the following paragraphs.

B. Swing Check Valves – HVAC Systems (Non-Potable Water Systems):

1. **CV-01 -** Bronze 2" and Under (Threaded and Soldered End Connections):

a) Valves shall be suitable for 125 SWP/200WOG, 150 SWP/300 WOG or 300 SWP/ 1000WOG, renewable disc, T-Pattern or Y-Pattern.

b) Body and Cap: Bronze ASTM B62.

c) Lever: Stainless steel or brass.

d) Disc: Bronze ASTM B16, ASTM B453, or ASTM B61.

e) Acceptable Makes: Milwaukee 509/1509 (Class 125) or 515/1515 (Class 150); Hammond IB904//IB912 (Class 125) or IB515Y (Class 150); Crane 37/ (Class 125) or 137 (Class 150); Nibco T-413/S-413 (Class 125) or T-433/S-433 (Class 150); Apollo 161T (Class 125), 164T (Class 150).

2. **CV-03 -** Cast Iron 2 ½" and Larger (Flanged End Connection):

a) Valves shall be Class 125 or Class 250, bolted cap.

b) Body and Bonnet: Cast iron ASTM A126, Class B.

c) Seat Ring: Bronze ASTM B62

d) Disc: Cast iron ASTM A126, Class B or cast bronze ASTM B62

e) Hinge: Ductile iron ASTM A536 or cast bronze ASTM B62.

f) Acceptable Makes: Milwaukee F-2974A (Class 125) or F-2970-M (Class 250); Crane 373 (Class 125) or 39E (Class 250); Powell Figure 559 (Class 125); Lunkenheimer Figure 1790 IBBM (Class 125); Nibco F-918-B (Class 125) or F-968-B (Class 250).

C. Ball Valves – HVAC Systems (Non-Potable Water Systems):

1. **BV-03 -** Bronze 2" and under (Threaded and Soldered End Connections)

a) Valve shall be suitable for 600 psi WOG non-shock, 150 psi WSP full port with blowout proof stem.

b) Body: Bronze.

c) Stem: 316 Stainless Steel.

d) Ball: 316 Stainless Steel.

e) Seats and Seals Stem Packing and Thrust Washer: PTFE.

f) Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.

g) Adjustable stem packing.

h) Acceptable Makes: Watts LFB6080-G2-SS (threaded) and LFB6081-G2-SS (solder); Apollo 77C-140 (threaded) and 77C-240 (solder); Milwaukee BA400S (threaded) and BA450S (solder); Nibco T-585-66 (threaded) and S-585-66 (solder); Hammond 8303A (threaded) and 8313A (solder).

2. **BV-08 -** Carbon Steel 2 1/2" to 12" (Flanged End Connection):

a) Valve shall be Class 150 designed for 285 psi WOG non-shock, full port, split body, raised face flange, with blowout proof stem conforming to ANSI/ASME B16.34, ANSI/ASME B16.10, ANSI/ASME B16.5, MSS SP-25 and MSS SP-72

b) Body: ASTM A216 GR WCB Carbon Steal.

c) Stem: Stainless steel Type 316 ASTM A276.

d) Ball: Stainless steel Type 316 ASTM A276.

e) Seats and Seals Stem Packing and Thrust Washer: PTFE/RPTFE.

f) Handle: Lever for valves below 6" and gear operators for 6" through 12".

g) Adjustable stem packing (graphite).

h) Acceptable Makes: Milwaukee F20CS; Nibco F-515-CS-F-66-FS (Class 150); Jamesbury 9150 (Class 150); Apollo 87A-200 Series (Class 150); Watts G4000 and G4000M1 (Class 125)

D. Valves for Gauges and Instruments – HVAC Systems (Non-Potable Water Systems):

1. Ball valve ½" in size meeting the requirements above for the services specified.

E. Hose Threaded Drain and Manual Vent Valve (Non-Potable Heating Hot Water, Chilled Water, Heating Glycol and Cooling Glycol Systems Operating at a maximum pressure of 125 psi and temperature of 200°F or Below):

1. **DBV-01** - Bronze ½" and ¾" (Threaded and Soldered End Connections)

a) Valve shall be suitable for 400 psi CWP, 2-piece, full port ball valve with blowout proof stem, ¾" hose connection.

b) Body: Bronze ASTM B584 or Brass ASTM B283.

c) Stem: Brass ASTM B16, silicon bronze ASTM B371 alloy C69430 or ASTM B99 alloy C65100.

d) Ball: Chrome plated brass ASTM B16 alloy C36000, ASTM B125 alloy C37700 or ASTMB282 alloy C37700.

e) Seats and Seals Stem Packing and Thrust Washer: PTFE and RPTFE.

f) Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.

g) Adjustable stem packing.

h) Acceptable Makes: Watts LFFBV-3C-CC (threaded) and LFFBVS-3C-CC (solder); Apollo 70-100-HC (threaded) and 70-200-HC (solder); Milwaukee BA100H (threaded) and BA150H (solder); Nibco T-585-70-HC (threaded) and S-585-70-HC (solder); Hammond 8501H (threaded) and 8511H (solder).

F. Balance Valve:

1. **General:**

a) Where contractor submits "termination kits" with integral balance valve for approval, use does not preclude the need to provide separate equipment isolation valve. Balance valves are not to be used for isolation duty. Provide separate isolation valve in compliance with Exhibit A of this section.

2. **GBV-01** - Globe Type Balancing Valve:

a) Balancing valve and flow meter stations suitable for use on heating and cooling systems.

b) Maximum Pressure Drop 5.0 Ft. or less.

c) Calibrated balance valve with provisions for connecting a portable differential pressure meter. Meter connections to have built-in check valves.

d) Multi-turn handle for precision adjustment.

e) Balance valve size shall be based upon gpm range rather than pipe size. Select flow balancers such that the range of pipe flow resides in the middle 50% of the manufacturer's recommended operating range for the device.

f) Operating temperature range -4 – 248°F. Suitable for 300psi at 150°F.

g) Brass: Solder or threaded body to match piping system up to 2".

h) Cast Iron: Grooved or flanged bodies to match piping system 2 ½ - 12".

i) Acceptable Makes: Armstrong CBV; Tour & Anderson 780 Series; Griswold "Speedset"; Macon STV

## PART 3 – EXECUTION

### 3.01 INSTALLATION

A. General:

1. Provide valves of type called for and where required to service equipment.

2. Provide at major building and system sections.

3. Isolating valves for individual fan convectors, room units, terminal units, or other similar apparatus may be inside cabinet or at connection to branch main where accessible.

4. Locate valves with stems at or above horizontal positions and swing check valves in horizontal position only.

5. Provide hose threaded drain valves at all piping system low points, strainers, equipment, and as called for heating hot water systems, chilled water systems, glycol heating systems and glycol cooling systems operating at or below 125 psi and 200°F. Drain or blowdown valves for water and glycol systems operating above 125 psi and 200°F, and steam systems shall be provided with valves specified in Exhibit 'A'. Provide Cap or plug at valve discharge.

B. Install self-regulating flow control valves as recommended by manufacturer. All flow control valves shall have strainer upstream of valve. Strainer shall be as specified in part 2 – Self Regulating Flow Control Valves.

C. Balance Valves:

1. Provide on zone or riser returns, on each hydronic unit and where called for. Meter connection points shall not point downward.

2. Install device in pipe line per manufacturer's instructions for upstream and downstream distances.

### 3.02 VALVE SELECTION

A. Provide valve types for the specific services as specified in Exhibit 'A'. Valve changes shall be made only as reviewed by Owner's Representative.

**EXHIBIT - 'A' - VALVE TYPE (HVAC)**

Notes are at the end of Exhibit 'A'

| Service | Gate | Globe | Check | Ball | Butterfly | Plug | Balancing | Special Purpose, Drains and Manual Air Vents | Notes |
|---|---|---|---|---|---|---|---|---|---|
| Hot water heating operating at 125 psi or below (Optional) | | | CV-01 Class 125 and CV-03 Class 125 | BV-03 and BV-08 Class 150 | | | GBV-01 | DBV-01 | Note 1, 2, and 3 |

NOTES FOR EXHIBIT "A":

NOTE 1: Hose threaded drain and vent valves DBV-01 shall only be used on heating hot water, chilled water, glycol heating and glycol cooling systems operating pressure at or below 125 psi and temperature at or below 200°F. Systems operating pressure above 125 psi and operating temperature above 200°F, or sizes above ¾" shall be provided with the listed service valve with the open end of the valve provided with a threaded plug or cap.

NOTE 2: The use of butterfly valves is not allowed.

NOTE 3: Where options are indicated for the valve connection types (threaded, soldered or welded) in this specification section, refer to Specification Section 232000 for the specific requirement for the connection type for the intended service.

## END OF SECTION

# PART 1 – GENERAL

## 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.02 SECTION INCLUDES

A. Review for adequacy all curbs, rails and support systems proposed by Division 23 to withstand calculated wind loads.

B. Support and brace mechanical (Div 23) systems to resist directional wind forces (lateral, longitudinal and vertical)

C. Provide restraint / attachment requirements for mechanical, electrical and plumbing systems to curbs, rails and support systems , and restraint / attachment of curbs, rails and support systems to the structure.

## 1.03 APPLICABLE CODES AND STANDARDS

A. Provide work in compliance with the following codes and standards.

B. Building Code of New York State, Section 1603.

C. Mechanical Code of New York, Section 301.

D. American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures – Standard ASCE/SEI 7-10.

## 1.04 QUALITY ASSURANCE

A. General:

1. The contractor shall provide calculations and details of wind restraint systems to meet total design lateral force requirements for support and restraint of mechanical and electrical systems, sealed and signed sealed by a New York registered Professional Engineer.

2. Systems requiring wind restraint:

a) Roof exhaust fans.

b) Roof Curbs.

## 1.05 SUBMITTTALS

A. Submit wind force level (Fp) calculations for applicable building code. Submit pre-approved restraint selections, installation details, and plans indicating locations of restraints.

B. Calculations, plans, restraint selection, and installation details shall be signed and sealed by a professional engineer licensed in the State of New York and experienced in wind restraint design.

C. Submit manufacturer's product data.

D. For each piece of equipment that requires wind restraint as outlined in this section, include the following:

1. Dimensioned Outline Drawings of Equipment Unit: Identify the center of gravity and locate and describe mounting and anchoring provisions.

2. Anchorage: Provide detailed description of equipment anchorage devices on which the calculations are based and their installation requirements. Identify anchor bolts, studs and other mounting devices. Provide information on the size, type and spacing of mounting brackets, holes and other provisions.

## PART 2 – PRODUCTS

### 2.01 CODE INFORMATION

A. This project is subject to the wind bracing requirements of the Building Code of New York State, International Building Code and American Society of Civil Engineers ASCE 7. The following criteria are applicable to this project, see Structural Engineering plans for data.

1. Basic Wind Speed (V) (Per ASCE 7-10).

2. Importance Factor (I) (Per ASCE 7-10).

3. Exposure Category (Per ASCE 7-10).

4. Height and Exposure Adjustment Coefficient (Per ASCE 7-05).

5. The mean height of the structure ($h_{mean}$) shall be determined thru coordination with Architectural plans and the General Contractor.

### 2.02 WIND BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Design analysis shall include calculated dead loads, wind loads, and capacity of materials utilized for the connection of the equipment or system to the structure.

2. Analysis shall detail anchoring methods, bolt diameter, and embedment depth.

3. All wind restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 2.1.

B. Friction from gravity loads shall not be considered resistance to wind forces.

## PART 3 – EXECUTION

### 3.01 INSTALLATION

A. Wind Restraint of Equipment:

1. All restraint systems shall be installed in strict accordance with the manufacturer's restraint guidelines and all certified submittal data.

2. The interaction between mechanical and electrical equipment and the supporting structures shall be designed into the restraint systems.

3. Friction clips shall not be used for anchorage attachments.

4. Expansion anchors shall not be used for non-vibration isolated equipment rated over 10HP.

5. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction and vertical restraints shall be provided to resist overturning.

6. Installation of restraints shall not cause any change in position of equipment or ductwork, resulting in stresses or misalignment.

7. No ridged connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

8. Do not install any equipment or duct that makes rigid connections with the building unless isolation is not specified.

9. Prior to installation, bring to the Architect's/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

10. Bracing may occur from flanges of structural means, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult Structural Engineer of record.

11. Overstressing, of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The Contractor shall submit loads to the Structural Engineer of record for approval in this event.

12. Brace support roads when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

13. Provide reinforced clevis bolts where required.

14. Do not brace a system to two independent structures such as a roof and wall.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

## 1.02 QUALIFICATIONS

A. All identification devices shall comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles.

## 1.03 SUBMITTALS

A. Prior to Ordering Products: Submit manufacturer's technical product data and installation instructions for each identification material and device. For valve tags include proposed tag methodology, including code number, location and valve function. For piping systems and equipment submit proposed schedule of pipe, equipment and name identification for review and approval. Confirm naming / numbering is consistent with any Owner's naming / numbering convention.

B. As-built submission – Provide final valve schedule for each piping system in both 8-1/2 in. X 11 in. (minimum) and WORD format, indicating code number, location and valve function.

## 1.04 MAKES

A. Allen Systems, Inc., Brady (W.H.) Co.; Signmark Div., Industrial Safety Supply Co., Inc., Seton Name Plate Corp., Marking Services Incorporated, or approved equal.

# PART 2 - PRODUCTS

## 2.01 GENERAL

A. Provide manufacturer's standard products of categories and types required for each application. In cases where there is more than one type specified for an application, selection is installer's option, but provide single selection for each product category.

## 2.02 PIPING IDENTIFICATION

A. Identification Types:

1. Pressure sensitive type: Provide manufacturer's standard pre-printed, permanent adhesive, color coded, pressure sensitive, vinyl pipe markers complying with ANSI A13.1.

B. Lettering:

1. Piping labeling shall conform to the following list:

| Pipe Function | Identification |
|---|---|
| Heating Water Supply | HWS |
| Heating Water Return | HWR |

### 2.03 VALVE IDENTIFICATION

A. Valve Tags:

1. Standard brass valve tags, 2" diameter with 1/2" high numerals. Identify between heating and plumbing services with 1/4" letters above the valve number.

2. Equal to Seton Style 300 Cat.

B. Valve Chart:

1. Provide valve chart for all valves provided as a part of this project. Frame and place under clear glass. Hang in Mechanical Room.

### 2.04 EQUIPMENT IDENTIFICATION

A. General:

1. Provide engraved acrylic or vinyl plates for each major piece of mechanical equipment provided.

2. Nameplates: 3/4" x 2-1/2" equal to Seton Cat. #2060-20.

3. Provide for the following equipment:

a) Unit Ventilators

b) Fans

## PART 3 - EXECUTION

### 3.01 GENERAL

A. Provide valve tags for all valves provided on project.

B. Provide equipment tags for all equipment listed in Equipment Identification Section above.

C. Provide piping identification with directional flow arrows for all piping on project. Maximum every 15'-0". Provide tags on piping at all coil terminations. For piping installed through rooms, provide at least one pipe label in each room, for each pipe function.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

B. This Contractor shall reference the entirety of Division 23 as it applies to this work.

C. Refer to specification Section 019113 for commissioning requirements related to this project.

D. Refer to temperature control drawings for additional balancing requirements associated with calibration and setup of temperature control sequences of operation. In addition to any additional requirements, all air flow measuring stations shall be field calibrated by traverse or other means that does not introduce duck leakage error into the final setting.

## 1.02 SUMMARY

A. Provide labor, materials, equipment and services to perform operations required for testing, adjusting, and balancing HVAC systems to produce design objectives, including, but not limited to the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.

    a) Refer to unit ventilator schedule for airflows to balance units too.

2. Adjusting total HVAC systems to provide indicated quantities.

3. Measuring electrical performance of HVAC equipment.

4. Setting quantitative performance of HVAC equipment.

5. Verifying that automatic control devices are functioning properly.

6. Calibration of flow (air and water) sensors provided by the 230923 contractor

7. Reporting results of the activities and procedures specified in this Section.

## 1.03 SUBMITTALS

A. Quality-Assurance Submittals: Submit copies of evidence that the Testing, Adjusting, and Balancing contractor and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" article below.

B. Sample Report Forms: Submit required number of sets of sample testing, adjusting, and balancing report forms.

C. Certified Testing, Adjusting, and Balancing Reports: Submit required number of copies of reports prepared, as specified in the Submission of Certified Balance Reports Section, on approved forms certified by the registered contractor; include registration number.

D. Warranty: Submit required number of copies of the warranty specified in the "Warranty" Article below.

## 1.04 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing contractor certified/registered by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractor shall have performed as a member in good standing with recognized procedures for no less than five (5) years including projects of the magnitude and design of this project. Balancing Contractor must be approved by the Engineer. See Section 1.3.

B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.

2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

C. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC or NEBB's Standards for Testing, Adjusting, and Balancing, or approved equal.

D. Instrumentation Type, Quantity, and Accuracy: As described in AABC or NEBB national standards.

E. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

## 1.05 PROJECT CONDITIONS

A. The Owner may occupy all or part of the site and existing building during the entire testing, adjusting, and balancing period as required. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations. It is the intent to have all possible balancing procedures complete prior to any Owner occupancy. Contractor shall perform the necessary work in an expedient and accurate manner which best serves the need of verifying proper installation and operation of the installed systems and allowing prompt Owner occupancy.

## 1.06 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls contractor, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Coordinate TAB activities with temperature control system setup and calibration

## 1.07 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by this Contractor under requirements of the Contract Documents.

B. NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing contractor fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified contractor has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.

3. Copy of the performance guarantee shall be included in each final certified air balance report.

# PART 2 - PRODUCTS

## 2.01 GENERAL REQUIREMENTS

A. Provide all required instrumentation and tools, including, but not limited to ladders, recording meters, gauges, thermometers, voltmeters, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers and tachometers. Instruments used shall be accurately calibrated as per AABC or NEBB requirements

# PART 3 - EXECUTION

## 3.01 EXAMINATION

A. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are located as required in the Contract Documents and installed per manufacturer's requirements. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operations. All deficiencies shall be reported to the Engineer in writing within 60 days from award of contract. Failure to provide notice within this time period may require that any devices required for proper balance of these systems be installed at the cost of this contractor.

B. Examine approved submittal data of all HVAC systems and equipment.

C. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions and/or cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems"; or in SMACNA's "HVAC Systems-Duct Design". Compare this data with the design data and installed conditions.

D. Examine system and equipment installations to verify that they are complete and ready for testing.

E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing. Any noted deficiencies should be reported immediately to the Engineer for further action.

G. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

H. Examine strainers for clean screens, removal of startup screens and proper perforations.

I. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature control system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.

2. Dampers and valves are in the position indicated by the controller.

3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multi-zone units, mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves are properly connected.

5. Temperature sensors are located to avoid adverse effects of sunlight, drafts, and cold walls. Sensors are located to sense only the intended conditions.

6. Sequence of operation for control modes is according to the Contract Documents.

7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.

8. Interlocked systems are operating.

9. Changeover from heating to cooling mode occurs according to design values.

M. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures immediately to the Engineer for further action.

## 3.02 PREPARATION

A. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete. Equipment rotation has been checked.

2. Hydronic systems are filled, clean, strainers cleaned, startup screens removed and system free of air.

3. Automatic temperature control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices has been provided.

8. Filters are clean and in place, including pre-filters and final filters where applicable.

## 3.03 GENERAL TESTING AND BALANCING PROCEDURES

A. All systems shall be tested and verified to be in compliance with the performance characteristics contained in the contract documents. All testing shall be performed in compliance with the requirements of NEBB or AABC Standards for Testing and Balancing, or within the standards described in this section. The more stringent standard shall apply.

B. Adjusting and balancing shall be accomplished as soon as the systems are completed to the extent required to allow the work to proceed, and before the Owner takes possession. Verify that the system is properly vented, cleaned, and strainers are cleared with startup mesh removed prior to balance.

C. Cut insulation, ducts, and pipes for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the Insulation Specifications for this Project.

D. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan speed control levers, and similar controls and devices, indicating final settings.

E. Adjusting and balancing shall be accomplished under appropriate outdoor temperature conditions. All outdoor conditions (Db, Wb, and a description of the weather conditions) at the time of testing shall be documented in the report.

F. Identify flow balancers and dampers in systems which cannot be manipulated to satisfy balancing requirements. Return to site after remedial actions are performed to adjust corrected systems.

G. Traverse duct mains to determine total air system delivery quantities after all outlets have been set and, if necessary prior to final adjustment if the system does not meet design requirements. A sum of room CFM's is not acceptable.

**3.04 FUNDAMENTAL AIR SYSTEM BALANCING PROCEDURES**

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan total volume.

1. Determine system diversity factors. Prepare plan to simulate system diversity

2. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

3. Check the airflow patterns from the outside air louvers and dampers and the return and exhaust air dampers, through the supply fan discharge and mixing dampers.

4. Locate start-stop and disconnect switches, electric interlocks, and motor starters.

5. Verify that motor starters are equipped with properly sized thermal protection.

6. Check dampers for proper position to achieve desired airflow path.

7. Check for airflow blockages.

8. Check condensate drains for proper connections and function.

9. Check for proper sealing of air-handling unit components

B. Air System Balancing Procedures:

1. The procedures in this article apply to all supply, return, and exhaust air systems. Additional procedures are required for variable air volume systems; these additional procedures are specified in the following articles in this specification.

2. Adjust fans to deliver total design air flows within the maximum allowable speed (rpm) listed by the fan manufacturer.

3. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

4. Measure static pressure across each air-handling unit component.

5. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions in the event that adverse resulting conditions occur which make the system unable to achieve design performance levels.

6. Adjust fan speed higher or lower as required to meet as installed conditions. Provide new sheaves as required. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan speed changes.

7. Do not make fan speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

8. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design air flows within specified tolerances.

    a. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved. Where sufficient space in submains and branch ducts is unavailable for pitot tube traverse measurements, measure air flow at terminal outlets and inlets and calculate the total air flow for that zone.

    b. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design air flows within specified tolerances.

9. Measure terminal outlets and inlets without making adjustments. Measure terminal outlets using a direct reading hood or the outlet manufacturer's written instructions and calculating factors.

10. Adjust terminal outlets and inlets for each space to within +/- 10% of design airflow. Make adjustments using volume dampers rather than the dampers at the air terminals, where available.

    a. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.

b. Adjust patterns of adjustable outlets for proper distribution without drafts.

c. Where pressure gradients are required between spaces, provide adjustment of supply and return / exhaust air such that the supply vs return / exhaust rate shown on the plan is maintained.

d. Record final air volume and air flow pattern for each inlet and outlet.

**3.05 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS**

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5%.

B. Verify that systems are prepared for hydronic systems testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.

2. Check flow control valves for specified sequence of operation and set at design flow.

C. Hydronic System Balancing Procedures:

1. Set calibrated balancing valves, if installed, at calculated pre-settings.

2. Measure flow at all stations and adjust, where necessary, to obtain first balance.

a. System components that have $C_V$ rating or an accurately cataloged flow pressure drop relationship may be used as a flow indicating device.

3. Measure flow at main balancing station and set main balancing device to achieve flow that is 5% greater than design flow. Where pump selection provides a firm operating point, pump flow may be derived from the pump curve in lieu of the balancing device.

4. Adjust balancing stations to within specified tolerances of design flow rate as follows:

a. Determine the balancing station with the highest percentage over design flow.

b. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.

c. Record settings and mark balancing devices.

**3.06 MOTORS**

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data as it applies.

1. Manufacturer, model, frame and serial numbers.

2. Complete nameplate data.

3. Efficiency rating if high efficiency motor.

4. Measured voltage and amperage, each phase

5. Starter thermal protection element rating.

**3.07 HEAT TRANSFER COILS**

A. Hydronic: Measure the following data for each coil.

1. System identification.

2. Location.

3. Coil Type and nameplate data

4. Dry-bulb temperatures of entering and leaving air.

5. For cooling coils – record entering %RH or wet bulb data.

6. For primary coils (Air Handlers, etc.) – Record face velocity and air pressure drop.

7. Record airflow rate

8. Adjust water flow rate as scheduled

9. Adjust bypass water flow on three-way circuits for 50% of total coil water flow scheduled.

**3.08 TEMPERATURE CONTROL VERIFICATION**

A. Verify that all control devices are calibrated and fully operational.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify free travel and proper operation of control devices such as damper and valve operators.

**3.09 TOLERANCES**

A. Unless noted to the contrary in other portions of the contract documents, set HVAC system airflow and waterflow rates within the following tolerances.

1. Supply, Return, and Exhaust, Air Inlets and Outlets: +/- 10%, maintaining required pressure balance between adjacent spaces / zones.

2. Fans at +/- 5% of delivery requirements.

3. Water-Flow Rates: +/- 5%.

**3.010 FINAL REPORT**

A. General: Computer printout in letter quality font, on standard bond paper. Provide 1 hard copy in 3-ring binder, tabulated and divided into sections by tested and balanced systems. Provide PDF copy for project record.

B. A certification sheet in front of binder signed and sealed by the certified testing and balancing agent. All reports shall bear the seal of the certifying agent for the balancing contractor. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: Final report shall consolidate data from all segments of phased project. In addition to the certified field report data, include the following:

1. Manufacturers' test data.

2. Field test reports prepared by system and equipment installers.

3. Other information relative to equipment performance; do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page including:

a. Name and address of testing, adjusting, and balancing contractor.

b. Project name.

c. Project location.

d. Architect's name and address.

e. Engineer's name and address.

f. Contractor's name and address.

g. Report date

2. Signature of testing, adjusting, and balancing agent who certifies the report.

3. Summary of contents, including the following:

a. Design versus final performance.

b. Notable characteristics of systems.

c. Description of system operation sequence if it varies from the Contract Documents.

4. Nomenclature sheets for each item of equipment.

5. Data for terminal units, including manufacturer, type, size, and fittings.

6. Report shall document all information items requested within this specification section.

E. Fan Test Reports: In addition to other requirements for supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangements and class.

g. Fan and motor sheave make, size in inches, bore, and key size.

h. Fan and motor sheave dimensions, center-to-center and amount of adjustment in inches.

i. Number of belts, manufacturer, and size

2. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

f. Motor data.

F. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record and report the following data as a minimum:

1. System and air handling unit number.

2. Location and zone.

3. Traverse air temperature in °F.

4. Duct static pressure in inches wg.

5. Duct size in inches.

6. Duct area in sq. ft.

7. Design airflow rate in cfm.

8. Design velocity in fpm.

9. Actual airflow rate in cfm.

10. Actual average velocity in fpm.

G. Instrument Calibration Reports: For instrument calibration, include the following data in report, as a minimum:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Date of calibration.

### 3.011 ADDITIONAL TESTS

A. Balance Contractor shall be prepared to verify the balance of select devices in the presence of the Engineer and / or Commissioning Authority at their discretion. This typically will require only a few hours to a day of labor, depending on the project scope. If, in the opinion of the Engineer or Commissioning Authority these verifications contain adequate discrepancies to provide doubt to the accuracy of the balance procedures performed, the Engineer or Commissioning Authority may order additional re-balancing or re-verification until such time as these discrepancies are eliminated throughout the systems; this verification shall be at the Contractor's expense.

B. Seasonal Periods: Initial testing, adjusting, and balancing procedures at start-up will not provide a good representative sample of system performance due to seasonal conditions. Therefore the Contractor shall return at a later time to perform the required balancing work, up to 8 hours of balancing work, to address seasonal conditions. This shall not delay the submittal of the certified balance reports for all work otherwise performed.

### 3.012 SUBMISSION OF CERTIFIED BALANCE REPORTS

A. Time is of the essence in the completion of this portion of the contract. It is expected that the certified balance reports will be submitted in a timely manner, within thirty (30) days of the work performed. At the completion of the project, it shall be the responsibility of this Contractor to assemble a single certified report and submit 1 copy to the Engineer as closeout documentation, along with electronic copy in PDF format.

## END OF SECTION

# PART 1 – GENERAL

## 1.01 WORK INCLUDED

A. All work shall comply with the requirements of the 2020 Energy Construction Conservation Code of New York State, manufacturer's requirements for installation and these specifications. In the event of conflicts between these documents, the more stringent requirements shall govern.

B. Provide labor, materials, equipment and services to perform operations required for the complete installation and related work as required in the Contract Documents. The extent of insulation work is indicated on the drawings and by the requirements of this section.

C. Repair all insulation at points of piping and ductwork system tie in to existing and at locations where existing systems are cut, patched or capped.

D. Insulate all existing piping systems, ductwork systems and equipment after removal of existing insulation whether by this contractor or another, including but not limited to removal of asbestos products.

E. Remove existing insulation where indicated on the drawings or specified here-in.

## 1.02 SUBMITTALS

A. Manufacturers' Data. Submit manufacturer's data and installation instructions.

B. Schedule of insulation applications.

C. Certification: Provide certifications as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

## 1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 232000 **–** Piping Systems and Accessories.

B. Section 232133 – Water Systems Specialties.

C. Section 233000 – Sheet Metal and Ductwork Accessories.

# PART 2 – PRODUCTS

## 2.01 GENERAL

A. Insulation, Jackets, Adhesives, and Coatings, shall comply with the following:

1. Treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments are not permitted.

2. Insulation, including finishes and adhesives on the exterior surfaces of ducts, pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, as tested by ASTM E84 (NFPA 255) and UL 723 methods, using the specimen preparation and mounting procedures of ASTM E2231.

3. Insulation within plenums, duct coverings and duct linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F. Pipe and duct insulation shall be listed and labeled.

4. All adhesives, coatings and sealants used for the insulation shall comply with the maximum Volatile Organic Compound (VOM) limits as called for in the current version of U.S. Green Building Council LEED Credits.

5. Provide materials which are standard insulation products of manufacturers for piping, ductwork and equipment systems.

6. Provide insulation in accordance of MICA and NAIMA standards.

7. Asbestos or asbestos bearing materials are prohibited.

8. Ducts operating at temperatures above 120 degrees shall have sufficient thermal insulation to limit the exposed surface temperature to 75 degrees.

9. The insulation shall be clearly labelled by the manufacturer with the installed thermal “R” values in accordance to the Energy Conservation Code.

10. UL GREENGUARD Gold Certification – all insulation materials shall be GREENGUARD certified, documentation for which shall be contained in the paragraph 1.2.c submittal information.

## 2.02 ACCEPTABLE MANUFACTURERS

A. Fiberglass: Knauf, Manville, Owen-Corning, Certainteed.

B. Calcium Silicate: Industrial Insulation Group (IIG), Johns Manville, Owens-Corning.

C. Adhesives, Coatings, Mastics, Sealants: Childers, Foster, Armacell.

D. Aluminum and Stainless Steel Jacket Material: GIC, GLT, RPR.

E. Laminated Rubberized Bitumen Jacket: Alumaguard, VentureClad, Flex Clad.

F. Pre-Molded PVC Fitting Covers: Zeston, Proto System

## 2.03 PIPE INSULATION (RIGID FIBERGLASS TYPE)

A. Glass Fiber insulation meeting ASTM C 547, Type II, Class 2, ASTM C 585, ASTM C 795 and ASTM C 1136; rigid, molded, noncombustible.

B. Minimum 'K' Value: ASTM C 335, 0.23 at 75°F mean temperature installed value. Maximum Service Temperature: 1000°F.

C. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C 1136 Type I, secured with self-sealing longitudinal laps and butt strips.

D. Field-Applied PVC 30 mil Fitting Covers with Flexible Fiberglass Insulation complying with ASTM C 450 and ASTM C 585: Proto Corporation LoSmoke, UV-resistant fittings and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with blanket type fiberglass wrap inserts. Blanket fiberglass wrap inserts shall have a thermal conductivity ('K') of 0.26 at 75°F mean temperature. Closures to be stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

## 2.04 PIPE INSULATION TAPES

A. ASJ (All Service Jacket) Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 4 inches.
2. Thickness Total: 0.19mm
3. Adhesion: Exceeds strength of tape back.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. Make: 3M Venture Tape 1540CW, Owens Corning ASJ Max or approved equal

B. FSK (Foil. Scrim and Kraft Laminate) Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 4 inches.
2. Thickness Total: 5.5 mil.
3. Adhesion: 66 ounces force/inch in width.
4. Elongation: 2 percent.
5. Ambient Limits: -40 to 240 deg F
6. Tensile Strength: 39 lbf/inch in width.
7. Make: Owens Corning Thermafiber. 3M Venture Tape 1525CW, or approved equal.

## 2.05 DUCT INSULATION

A. Duct Liner – Refer to Specification Section 233000.

B. Flexible Fiber Glass Blanket:

1. Insulation Blanket meeting ASTM C 553, Type II, ASTM C 1290, Type III, and ASTM C 1138.
2. 'K' Value of 0.27 at 75°F mean temperature. Maximum Service Temperature (Faced): 250°F.
3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, II, III, IV, VIII or FSK conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.
4. Installation: Maximum allowable compression is 25%.

5. Density: Minimum 1.0 PCF.

6. For duct wrap, the installed thickness shall be assumed to be 75 percent (25% compression) of nominal thickness.

C. Rigid Fiber Glass Board

1. Insulation Board meeting ASTM C 612 Type IA, IB and II, ASTM C 795 and ASTM C 1138.

2. 'K' Value of 0.23 at 75°F mean temperature. Maximum Service Temperature: 450º F.

3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.

4. Concealed Areas: Minimum 3 lb./ft.$^3$.

5. Exposed Areas: 6 lb./ft.$^3$ minimum density for duct less than 8 ft. - 0 in. above finished floor or where indicated in these specifications or on the drawings.

D. Duct Insulation Tapes:

1. ASJ (All Service Jacket) Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

a) Width: 4 inches.

b) Thickness Total: 0.19mm

c) Adhesion: Exceeds strength of tape back.

d) Elongation: 2 percent.

e) Tensile Strength: 40 lbf/inch in width.

f) Make: 3M Venture Tape 1540CW, Owens Corning ASJ Max or approved equal

2. FSK (Foil. Scrim and Kraft Laminate) Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

a) Width: 4 inches.

b) Thickness Total: 5.5 mil.

c) Adhesion: 66 ounces force/inch in width.

d) Elongation: 2 percent.

e) Ambient Limits: -40 to 240 deg F

f) Tensile Strength: 39 lbf/inch in width.

g) Make: Owens Corning Thermafiber. 3M Venture Tape 1525CW, or approved equal.

### 2.06 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass Fiber Fabric: Approximately 6 oz. /sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts and equipment. Childers CHIL-GLAS #5 or equal.

### 2.07 COATINGS, MASTICS, ADHESIVES AND SEALANTS

A. Vapor Barrier Coatings: Used in conjunction with reinforcing mesh to coat insulation on below ambient services temperatures. Permeance shall be no greater than 0.08 perms at 37 mils dry as tested by ASTM D5590 meeting zero growth rate for mold. Foster 30-80 or approved equal, or approved equal.

B. Lagging Adhesives: Used in conjunction with canvas or glass lagging cloth to protect equipment/piping indoors. Foster 30-36 AF meeting ASTM D 5590 with zero mold growth rating, or approved equal.

C. Fiberglass Adhesive: Used bond low density fibrous insulation to metal surfaces. Shall meet ASTM C916 Type II. Foster 85-60; Childers CP-127, or approved equal.

D. Insulation Joint Sealant: Vapor sealant for below ambient piping with polyisocyanurate and cellular glass insulation. Foster 95-50; Childers CP-76, or approved equal.

## PART 3 – EXECUTION

### 3.01 GENERAL REQUIREMENTS

A. Provide Thermal Insulation:

1. Insulation is required on ductwork, piping and equipment in compliance with these specifications and referenced codes and standards.

2. Continuous through openings, sleeves and hangers.

3. Install only on clean, dry surfaces and after ductwork has been tested.

4. On cold surfaces provide continuous unbroken vapor seal. Exceptions - Do not cover inspection stampings, nameplate data, openings, petcocks, hand-holes, manholes, access doors, plugged outlets, air vents, plugged openings or petcocks. Provide continuity of insulation system and vapor barrier though partitions, floors, casings, plenums, etc.

### 3.02 PIPE INSULATION

A. Insulate piping systems including fittings, valves, flanges, unions, strainers, and other attachments installed in piping system, whether exposed or concealed, with the following exceptions:

1. Factory-installed piping within the HVAC equipment tested and rated in accordance with the 2020 ECCCNYS

2. Factory installed piping within room fan coil Units and unit ventilators tested and rated according to AHRI 440 and AHRI 840, respectively.

3. Piping that conveys fluids that have a design operating temperature range between 60 and 105 degrees.

4. Piping that conveys fluids that have not been heated or cooled through use of fossil fuels or electric power, the surface temperature of which does not risk condensation or occupant / service hazard (between 60°F and 105°F).

5. Strainers, control valves and balance valves associated with piping 1 inch or less in diameter and conveying fluids over 60 degrees.

B. Piping in exterior walls, spaces, overhangs, attics, or where subject to freezing, double the thickness of the insulation. Piping in wall chases adjacent to an exterior wall shall be packed with type glass fiber batting type insulation.

C. Hanger Shields: Refer to Section "Piping Systems and Accessories."

1. Pre-insulated type: Butt insulation to hanger shields and apply a wet coat of vapor barrier cement to the joints and seal with 3 in. wide vapor barrier tape.

D. Joints in sections of pipe insulation shall be made as follows:

1. Standard: Longitudinal laps and butt joint shall be fully sealed. Factory applied pressure sensitive adhesive lap seal is acceptable.

2. Vapor barrier: For cold services, all service jacket (ASJ) longitudinal laps and 4 in. vapor barrier strip at butt joints shall be sealed with vapor barrier coating. Seal ends of pipe insulation at valves, flanges, and fittings with vapor barrier coating and reinforcing mesh.

E. Fittings, Valves and Flanges:

1. Hot services: Pre-molded fitting insulation of the same material and insulation value as the adjacent pipe insulation.

2. Hot water shall be coated with weather barrier mastic and reinforcing mesh.

3. Provide PVC fitting covers on all fittings.

**3.03 DUCTWORK INSULATION**

A. External thermal insulation for duct. Not required where ducts have internal acoustical insulation, are located inside the conditioned space and lining meets the insulation value of these specifications and the 2020 ECCCNYS. Make special provisions at dampers, damper motors, thermometers, instruments, and access doors. Apply as Follows:

1. Rigid board type: Impale board over mechanical fasteners, welded pins or adhered clips, 12 in. to 18 in. centers; minimum of two rows per side. Secure insulation with washers on clips. Seal breaks and joints in vapor barrier with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating. Apply tape over corner beading where exposed. Flexible blanket type: Joints and seams made with 2 in. lap of vapor barrier. Round ducts: Apply Foster 85-20 adhesive to ducts in 6 in. brush widths at 1 ft. intervals and at each facing edge. Square ducts: Over 18” duct face width, fasten by impaling insulation on adhered or welded clips. Secure insulation with washers on clips. Seal joints and breaks with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating. Cooling ducts shall be covered with a vapor retarder having a maximum permeance of 0.05perm or an aluminum foil jacket with a minimum thickness of 2 mils. All joints and seams shall be sealed to maintain the continuity of the vapor retarder.

2. Flexible blanket type: Joints and seams made with 2 in. lap of vapor barrier. Round ducts: Apply Foster 85-20 adhesive to ducts in 6 in. brush widths at 1 ft. intervals and at each facing edge. Square ducts: Over 18” duct face width, fasten by impaling insulation on adhered or welded clips. Secure insulation with washers on clips. Seal joints and breaks with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating.

3. Expanded polystyrene: Impale over glued pins, 12 in. to 18 in. centers, minimum of 2 rows per side. Secure insulation with washers on clips. All insulation shall be covered with 0.016" embossed aluminum jacket. Corners shall be protected with aluminum corner bead, screwed to jacketing. All seams and breaks to be weatherproofed and caulked. All joints to be cleanly finished.

4. Insulate the tube bends and all exposed surfaces of duct coils operating in excess of 10 degrees differential from ambient conditions.

B. Service and access openings shall not be concealed by duct coverings unless the exact location of the opening is properly identified.

C. Continuous vapor barriers shall be provided on all ductwork subject to condensation. No gaps or methods for air to permeate the insulation materials below the vapor barrier shall be permitted.

**3.04 RECOVERING**

A. Field apply glass cloth and applied over standard insulation jacket with lagging adhesive. Properly cut at fittings to avoid wrinkles and coat with lagging adhesive. Leave ready for painting.

**3.05 EXISTING INSULATION**

A. Patch existing insulation damaged during the course of the work.

B. Report any deficiencies in existing insulation systems to the Owner's Representative for further action.

**3.06 EXISTING WORK**

A. Insulate existing piping, ductwork and equipment where called for.

**EXHIBIT "I" - PIPE INSULATION MATERIALS**

| SERVICE | INSULATION MATERIAL | THICKNESS | REMARKS |
|---|---|---|---|
| Hot water (200°F and lower) | Glass fiber (k=.25-.29) | 1-1/2 in. and Larger: 2 in.<br>1-1/4 in. and Smaller: 1-1/2 in. | |

**EXHIBIT "II" - DUCT INSULATION MATERIALS**

| SERVICE | INSULATION MATERIAL | THICKNESS | REMARKS |
|---|---|---|---|
| Exhaust, relief or vent ducts and plenums | Exposed:<br>Rigid fiberglass<br>Concealed:<br>Flexible fiberglass | 1-1/2 in.<br><br>2 in. | Min. installed R value of 8<br>Insulate 15 ft. from exterior opening and plenums |

## END OF SECTION

# PART 1 – GENERAL

## 1.01 FUNCTIONAL INTENT

A. Accessibility: As much as practical, design the system to keep the BACS equipment out of, and above user areas. The maintenance staff must have quick and ready access with sufficient room for operation and maintenance.

B. Reliability: Controls are integral to maintaining reliable conditions throughout the building and as such need to be designed and installed with an appropriate degree of robustness and reliability.

C. Digital Terminal Unit Control - This intent of this standard is to require digital electronic control down to the terminal level. Terminal level controls will typically be cost-effective controllers designed for the specific application. Stand-alone local controls may only be used when specifically approved by the Engineer.

D. Expandability - When configuring the BACS equipment, provision must be made for expansion that may be required in the future. Hardware and software required to implement expansion must be provided via system sizing, configuration, and appropriate license agreements

E. When a portion of an existing building is to be renovated, the new control system shall match or integrate seamlessly with the existing control system.

F. Unless stated to the contrary, all hardware points (AI, AO, BI and BO) shall be hardwired to controllers. Data points / BACNet Objects are only to be accessed through equipment integration where specifically called for.

## 1.02 RELATED SECTIONS

A. This Contractor shall reference the entirety of Divisions 23 and 26 as they apply to this work, with specific attention to the following sections:

1. Section 019113 – Commissioning Requirements

2. Section 230514 – Electric Wiring

3. Section 230593 – Testing, Adjusting and Balancing

## 1.03 DEFINITIONS

| | |
|---|---|
| Binary Input (BI) | An on/off indication that has a maximum cycle rate of 1 Hz. This is typically sensing a contact closure |
| Binary Output (BO) | A contact closure on the controller that will cause inaction in the system |
| Binary Value (BV) | A network-visible binary point whose value is determined by a controller computation |
| Analog Input (AI) | A continuously varying voltage or amperage signal that is varied by a sensor in relation to a sensed variable. This signal is processed in the controller after an analog-to-digital converter on the controller that converts the analog signal to a digital value |
| Analog Output (AO) | A continuously varying voltage or amperage signal that is generated from the controller after digital-to-analog conversion. The voltage or amperage signal will be used, for instance, to drive a modulating actuator or reset a hardwired set point on a packaged device. 6. Analog Value (AV): A network-visible analog point whose value is determined by a controller computation |
| Analog Variable / Value (AV) | A network-visible analog point such as a setpoint or calculation result whose value is determined by a controller computation or user input |
| Building Management System (BMS) | Integrated DDC Temperature control system used both for system operation and troubleshooting meeting the requirements of this specification. |

## 1.04 WORK INCLUDED

A. Provide labor, materials, equipment, services and warranty for a complete installation, startup and commissioning of motor control wiring and temperature control wiring as required in Contract Documents.

B. Provide wiring and conduit required to connect devices furnished as a part of, or integral to the automatic temperature control system, and for motor control and interlocks regardless of the source of supply.

1. Control wiring includes, as required, 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 24VAC in general, and no more than120 VAC where required.

2. Provide wiring in accordance with the requirements specified in Division 26, "Electrical", Section 230514 and the National Electrical Code.

3. Provide all devices required for proper system operation including electrical switches, transformers, disconnect switches, relays, device controllers and control modules, hubs, routers, temporary servers, actuators, transducers, sensors, safety devices, power supplies, mode selecting switches, enclosures, and circuit breakers.

4. Provide complete wiring and terminations. Provide all assembly, programming and test of all items as necessary to create a coherent system, encompassing all combined intents of design, drawings, specifications, addenda, and professional quality of work.

5. Assembly of all damper linkages and shafts, including extension through duct walls where applicable and mounting of actuators shall be by the Temperature Controls Contractor.

6. Mounting of all actuators and sensing devices shall be by the Temperature Controls Contractor.

C. The temperature controls contractor shall be responsible for extending 120vac power from power panels / circuit breakers to all temperature control panels.

D. Provide support requirements for Commissioning as described in Section 019113. The DDC temperature control system is a primary tool for HVAC Commissioning.

E. Coordinate all work with factory provided equipment controllers.

F. Coordination: Work with the Engineer, Commissioning Agent, air-balancing contractor, ventilation contractor, piping contractor and electrical contractor to provide proper and obstruction free component location, and system commissioning.

## 1.05 WORK NOT INCLUDED

A. Power wiring for motors, motor starters, adjustable speed drives, as well as the motors, motor starters, and adjustable speed drives (except in the case of equipment specified to have packaged controls/starters) are included in Division 26, "Electrical," unless otherwise called for.

B. Electrical wiring, interlocks or components specifically called out in the electrical specifications or drawings shall be included in the Division 26 scope of work.

## 1.06 ACCEPTABLE MANUFACTURERS

A. Erie County Community College has an existing Building Management System manufactured by Schneider Electric Direct Digital Controls system, provided by U&S Services (a division of Starktech) This project is designed around an extension of this system.

B. All control systems provided shall seamlessly integrate with the existing system without the use of integrator panels, routers, or any other hardware or software. The control system manufacturer shall guarantee that all new controls operate with the existing controls system.

C. Basis of Design: Schneider Electric

D. Acceptable Manufacturers: Must be compatible with existing BMS system.

**1.07 WORK INCIDENTAL TO TEMPERATURE CONTROL CONTRACTOR**

A. The temperature control contractor shall furnish the following materials, for installation by the contractor responsible for HVAC piping and sheet metal (Sections 232000 and 233000) scope of work.

B. For piping work - Section 232000 Contractor shall install:

1. Control valves in piping.

2. Immersion sensing wells in piping systems.

3. Valved pressure taps (typically for pressure switches or sensors)

C. For sheet metal work - Section 233000 Contractor shall install:

1. Automatic Control Dampers:

a) Control dampers, at the direction of the Temperature Controls Contractor.

2. The Mechanical Contractor shall provide access doors or other means of access through ducts or ceilings and walls for service and adjustment of controllers, valves, and dampers.

D. Control system manufacturer or their authorized representative shall furnish written details, instructions and supervision for the above trades to ensure proper installation, size, and location of any equipment furnished for installation by others.

**1.08 QUALITY ASSURANCE**

A. Acceptable Products: All products shall be proven to be functional and suitable in accordance with this specification for a period of warranty commencing on the day of transfer of completed project to the Owner. Demonstration of such warranty may be required prior to the submittal approval.

B. Contractor Qualifications: The Temperature Controls Contractor shall be factory-authorized by the respective manufacturer to provide pertinent installation and service.

C. Any subcontractors in employ of the Temperature Controls Contractor on this project must receive prior approval to be permitted work on this project.

D. Field Representation: The Temperature Controls Contractor shall staff the project with a field representative that has been factory-trained in the installation, programming and commissioning of the equipment specified. This representative must be in the direct employ of the Temperature Controls Contractor.

E. Coordination of Work During Construction – this contractor shall:

1. Protect work installed by other trades

2. Coordinate its work with other trades

3. Repair any damage caused by his work

4. Promptly correct all work that Engineer finds as defective or failing to conform to Contract Documents

5. Bear all cost of correcting of work found defective as described above.

## 1.09 SHOP DRAWINGS AND SUBMITTALS

A. Product Data: Submit for approval the manufacturer's technical product data for each component furnished as part of the control system. Data shall include dimensions, capacities, performance characteristics, electrical requirements, and material finishes. Data shall also include installation and start-up requirements.

B. Shop Drawings: Submit for approval control drawings detailing the following:

1. Network Block Diagrams and System Riser Diagrams: These diagrams shall depict all DDC components that make up the network. They shall provide specific detail on network terminations, and panel power requirements, including breaker allocation. Each DDC panel within the diagram shall list the equipment that it is controlling.

2. Point-to-point Termination Detail: These drawings shall be created for each unique control application type. Drawings that are typical for similar application shall state the application and quantity of that they represent, and the specifics for each. All wiring and piping required to install and operate the system shall be represented in these details. For terminations that are unknown at the time of submittal, or introduced over the course of project, properly designate these as “Field determined terminations,” and include in the As-built Drawings after completion. All wiring and piping shall be number coded on the drawings. These tag numbers shall be used during the installation, and shall appear at both ends of all conductors, including within any junction boxes.

3. Provide individual details for each control type, as described in the Sequence of Operation.

4. Provide spreadsheets of schedules for dampers, valves, wiring, fans and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.

5. For prefabricated control panels, provide panel’s interior and exterior layout details. These details shall depict the equipment layout and shall detail the panel wiring and piping.

C. Product Data: The BACS vendor shall submit manufacturer’s technical product data for each control device, panel, controller, and accessory furnished indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also, include installation, start-up, calibration, and maintenance instructions as well as all cable and tubing requirements.

D. Database Information: The submittal package shall contain detailed information on the point naming convention that is to be used.

E. Provide documentation for all sequences of operation that cannot be performed by stand-alone controllers and require non-controller-resident programs, or programs requiring retransmission to be effective on the controller’s output. Wherever possible, sequences of operation and associated inputs and outputs shall be contained on a single controller.

F. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface. All controllers and operator interface shall fully conform to ANSI/ASHRAE 135: Data Communication Protocol for Building Automation and Control Systems (BACNET).

**1.010** OPERATION AND MAINTENANCE MANUALS FOR COMPLETE PROJECT

A. Upon completion of installation and prior to the training, provide manuals containing the following information:

1. Installation and Service Manuals for all products and components

2. Calibration and Troubleshooting Procedures for all installed equipment and components.

3. List of location of all enclosures, controllers, sensors, transformers and other components as specified above

4. As-built Control Drawings with all modifications, changes and wiring details that depict actual installation. These shall include all final controller and device names, locations for concealed components (pressure sensors, etc.),wire tags, etc.

5. Sequence of operation – Describing in detail the operation of every piece of equipment subject to control by the DDC system. Each section of the sequence should contain the following:

a) Overview – describes what the intent is, what components are involved and provides a concise description of the piece of equipment to be described.

b) Occupied Mode – Describes the operation of this system during occupied periods.

c) Unoccupied Mode – Describes the operation of this system during unoccupied periods.

d) Alarm Mode - Describes operation of the system in the event of alarm condition and steps to restore system to normal operation. List all anticipated alarm conditions.

e) Each Component's individual Sequence - Describes the detailed operation of each component and how it interacts with the entire system.

6. Listing of the entire DDC controllers with database, software and programs and program locations.

7. Provide spreadsheets of schedules for enclosures, control modules, dampers, valves, wiring, fans, well, tap and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.

B. Provide laminated control diagrams in each control panel for each piece of major controlled equipment or system.

C. Backup database information in electronic format (other than resident on computer hard drive) to be left on-site that will allow the Owner to fully download the entire DDC System software, including programming point database, configuration, graphic screens and all library of typically composed objects, and details supporting navigation, screens and graphics.

D. Within five working days from the time of the final system commissioning, one (1) hard copy and one (1) electronic copy in PDF format of Operation and Maintenance Manuals shall be turned directly to the Engineer.

E. A Programmers Manual shall be provided with graphic and text descriptions of all functions required for software modifications and developments. The use and installation of high-level programming language shall be included in this manual. The manual shall include ASCII text (or block diagram printouts for graphical programming language based systems) of all DDC programs with the spreadsheet inventorying the name and location of each program. Each file shall be accompanied by a "plain English" description of the program operation by subroutine to assure that future programmers can easily modify the existing database. The manual shall contain computerized printouts of all data file construction including all point information, physical terminal relationships, scales and offsets, alarm limits, messages, schedules, etc. The manual should also contain:

1. System overview
2. Networking concepts
3. Launching browsers from log in
4. Schedule manipulation
5. Software upload and download instruction, including field devices
6. Trend and alarm creation and maintenance
7. Report generation
8. Backup procedure for entire system and modular controllers
9. Sequence of Operation

F. Section for each Major Piece of equipment – Contains the cutsheets for the controllers, custom programs, and relevant information pertaining to that piece of equipment. (IE: schedules for AHUs showing Equipment Tag, Controller address, serial #, airflow, and pertinent engineering units like MBH, GPM, etc…).

G. Wiring Details – Contains 8-1/2" x 11" drawings of all the wiring details shown throughout the set of drawings.

H. Instrumentation Cut sheets – Contains the Manufacturer's original cut sheets for all the instrumentation used on the job. (IE: Well sensor, transformers, enclosures, pressure sensors, etc.).

I. AutoCAD Drawings – All drawings shall be provided in Auto CAD format (i.e. each file format should have the ".dwg" extension), made as set of both, a set 11"x17" black and white and a set of 24"x36" (1 color set and 3 black and white sets). Drawing Sets consists of the following:

1. System Description Drawing – Shows the overview of the job and what is being controlled.
2. Network Riser Drawings – Shows how the network is connected between all the devices on the job
3. Detail drawing(s) – Shows all the wiring and piping details for the entire job – all other drawings refer to these drawings.
4. Individual Control panel drawings & Schematics (1 or 2 drawings per piece of equipment) Shows the EXACT wiring and layout of each control panel. Also shows the schematic representation of the system that is being controlled. (IE: AHU, HW Plant, Fan Coil, Etc.)

5. Controls Floor plans (at least 1 for each floor) – Shows the approximate location of the control panels, thermostats, equipment, network wiring, thermostat wiring and any specific controls required for the job. All this information is overlaid on top of the mechanical floor plan showing the architectural layout (Wall and room #'s).

J. All above shall be copied to an approved electronic format and released to the Owner.

**1.011 SYSTEM PRE-COMMISSIONING**

A. In addition to responsibilities described within section 019113, and prior to formal project commissioning contractor shall complete the following Pre-Commissioning requirements to assure operational readiness of equipment prior to conducting commissioning.

B. Equipment Start-up: Upon completion of installation, all equipment being controlled shall be initially started and tested on site using a workstation configured identically to that to be presented for permanent use by the Owner, including graphical user interface. Upon completion of all system pre-commissioning (and 019113 commissioning) the entire contents of the workstation, including all changes and corrections performed during these phases, shall be re-loaded to the permanent operator workstation.

C. System Pre-Commissioning shall document the following:

1. Measure, calibrate and adjust all analog inputs. This is to be performed in a manner that verifies that sensors meet the accuracy requirements as specified for the device. All measurements shall be taken using an instrument certified for accuracy within a 12 month period.

   a) Where multiple sensors are "in line" within an air handling system – such as VAV leaving air temperature sensors vs an AHU leaving air temperature, or return / mixed / coil discharge sensors (with economizer correctly positioned) within an air handler, only one of the sensors need be directly measured, and the balance may be validated against the reference sensor.

   b) Where multiple sensors are "in line" within a piping system, the system may be manipulated such that only one sensor need be directly measured, and the balance may be validated against the reference sensor.

2. Stroke all analog outputs from 0% to 100%

   a) Visually verify that all linkage adjustments are set properly.

   b) Verify and record range of operation for ASD commands

   c) Verify and calibrate ASD feedback signals to correspond with command signal and actual operating speed in either RPM or HZ.

3. Valves and Dampers shall fully close and provide tight shut-off.

   a) Hydronic coils – verify that no temperature rise / drop occurs with the valve commanded fully closed

   b) Economizers – Verify return air temperature =mixed air temperature at 100% return air position, mixed air temperature = outdoor air temperature at 100% outdoor air position

4. Verify that all binary outputs are properly energizing the controlled device.

5. Verify that all binary inputs are properly calibrated to accurately reflect status of monitored equipment

6. Adjust setpoints so that equipment operates properly. Tune all PID control loops to avoid unnecessary cycling of control equipment, overheating, sub-cooling, tripping of freezestats or other limit switches and safeties. Create trends for review by the Engineer and Commissioning Agent.

7. Provide control and operational assistance to the balancing personnel during testing and balancing procedures.

D. Communication Network Start-up: Verify from a host computer that all configured controllers are engaged in proper communication passing all configured points to viewing stations. Verify communication speed and level of transactions until it is acceptable and meets the requirements of this specification.

E. Software Verification: All programs and software functions shall be verified to be in compliance with the contract documents for proper sequence of operation.

F. Pre-Commissioning Report: A report shall be provided to the Engineer detailing the dates, times and person(s) performing each phase of the specified system pre-commissioning. This report shall detail when and who performed the individual processes described in this section, and documents the results of all testing procedures. Coordinate phasing of work such that this can be completed PRIOR to formal system commissioning.

G. Project commissioning is considered complete only once the following are completed:

1. Pre-commissioning as described under this paragraph 1.11 is performed, the associated report submitted and approved. All points connected to the BMS shall operate in full compliance with this specification before project substantial completion is acknowledged.

2. The project formal commissioning as outlined under section 019113 is performed, including completion of all remedial work to correct Issues log items,

3. A physical walk-though of the project, conducted by the Engineer or Commissioning Agent and attended by the Temperature Controls Contractor and Owner or their authorized representative is concluded

4. The complete set of required closeout documentation is provided by the contractors. The Owner has no right to refuse or delay a reasonably scheduled walk through. The Owner and Engineer shall determine the level of detail required for the walk-through, and may take this to a component level inspection, at their discretion.

**1.012 TRAINING**

A. Provide BMS training for up to four (4) Owner selected personnel.

B. After Section 019113 Commissioning is complete as specified, the Temperature Controls Contractor shall provide an on-site session detailing the layout of the BMS. This shall include network wiring routes, control panel locations, transformer locations, etc.

C. The Temperature Controls Contractor shall then provide an on-site session to review the entire Operations and Maintenance manual(s) with the Owner. This session shall also include but not be limited to:

1. Fundamental operation of the system

2. Training on setpoint adjustment and scheduling modifications

3. Operation and sequencing of control loops for all mechanical equipment being controlled

D. Provide telephone support and answer system relevant questions throughout the warranty period.

### 1.013 WARRANTY

A. Warranty for the entire control system shall commence upon completion and acceptance by the Engineer of the system commissioning as specified. The warranty includes fine-tuning of all dynamic elements of control system to achieve reasonable, efficient end equipment protective mode of operation.

1. **Standard manufacturer warranty shall apply to Air flow meters, Flow meters, and low voltage wiring and power wiring to panels.**

B. **Special warranty: Provide an extended five (5) year warranty that shall include parts & labor for years 1-2, and equipment parts only warranty for years 3-5 for the following control equipment; DDC controllers, temperature sensors, humidity sensors, relays, actuators, valve bodies and power supplies.**

C. Disclose to Owner and accommodate longer warranty periods if provided by components manufactured at the time of purchasing.

D. The Contractor shall provide all OEM recommended preventative maintenance of the installed work as described in the operating and maintenance manuals during the warranty period. In addition, the Contractor shall provide two (2) semi-annual service visits (i.e., one visit during the peak cooling season and one visit during the peak heating season) to test and evaluate the performance of the installed work. The Contractor shall provide a written report of the test and evaluation results. The service visits shall include, but not be limited to:

1. Checking and, if necessary, correcting the calibration of the sensors, transducers, and transmitters for airflow, liquid flow, pressure, and temperature.

2. Checking and, if necessary, correcting the operation of the dampers and damper actuators.

3. Checking and, if necessary, correcting the operation (i.e., monitoring and command) of the system points, graphics, and display functions.

E. Software and Hardware Updates: At the end of the first six months after acceptance, and during the subsequent six-month period, the BACS contractor shall update the equipment and any controllers, servers, workstations and HMI web servers with the latest modification and improvements in software, firmware, and hardware that the manufacturer may have incorporated in the furnished equipment.

F. Contractor shall, during the ensuing four seasons (one year), conduct periodic inspections and fine-tune all dynamic elements of the system with all costs of testing to be included in this scope of work.

## PART 2 – PRODUCTS

### 2.01 SYSTEM DESCRIPTION

A. General Requirements

1. A distributed logic control system, complete with Direct Digital Control (DDC) software shall be provided. This system is to control all mechanical equipment, as described on the project drawings and these specifications.

2. All BMS controllers, including (but not limited to) those for terminal units, air handlers, central mechanical equipment and systems shall be as manufactured by a single manufacturer, the hardware from which has been represented by this contractor for no less than a 10 year period.

3. All controllers for terminal units, air handlers, central mechanical equipment and the Microsoft Windows-based operator's terminal(s) shall communicate and share data.

4. All controllers shall be fully programmable.

5. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

6. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.

7. All control points associated with a single piece of equipment (air handler, VAV air terminal, heat exchanger, pump control, etc.,) shall be wired to the local controller. Network sharing of data via the network, for example, remote monitoring of a temperature sensor to control a valve or other devices, shall not be permitted without advance permission from the Engineer.

8. The Temperature Controls Contractor shall assume complete responsibility for the entire controls system as a single source, providing installation, program debugging and service of all portions of logic control system. This shall include designated server, operator's terminal, global controllers, routers, terminal unit controllers, sensors and all other sections of the system.

9. During construction, at least one operator's terminal shall be equipped to act as a system server / operator interface. This system server shall store copies of all installed software for all field components and shall be capable of automatic or manual reloading of such software into the field components as required. The system server shall also gather and archive system-operating data, such as trends, energy logs, and other historical operating data. Complete energy management firmware, including self-adjusting optimum start, demand limiting, global control strategies and logging routines for use with total control systems shall be supplied. All energy management firmware shall be resident in field hardware and shall not be dependent on the operator's terminal for operation. Operator's terminal software is to be used for access to field-based energy management control firmware only. All schedules shall be module resident and shall not be affected in case of interruption network transport between the module and the host station.

10. Upon completion of the project, the Contractor shall transfer and install to all software, graphics, etc., associated with the scope of this project to the existing operator workstations.

B. Basic System Features

1. Direct digital logic control of temperature, scheduling, optimum start, equipment alarm reporting and override devices for unoccupied mode of operation.

2. Operator's terminal software (Graphical User Interface or GUI) shall run under Microsoft Windows operating system. Software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Operation of the terminal software shall be simple and intuitive.

3. Operator's terminal software shall contain graphical user interface software, allowing configuration of system-wide controllers.

4. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for network communications and interface to the internet as required to allow for remote access to system operations.

5. The system shall meet peer-to-peer communication services such that the connection of any operator interface to any one controller shall allow the operator to interface with all other controllers. The software shall provide transparent viewing and editing of all data, control programs, schedules, trends, alarms from any one controller through connection to any other controller on the internet work, regardless of subnetwork routers.

6. Priority password security systems shall prevent unauthorized use. Each user shall have an individual password. The user shall only be given access to the system functions required for individual job performance.

7. Equipment monitoring and alarm functions, including information for diagnosing equipment problems shall be included with the system.

8. The complete system, including, but not limited to terminal unit controllers, higher level controllers and operator's terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in any controller's memory shall reside error free for a minimum of 30 days. Logic controllers for all air handlers and all unitary equipment shall utilize EEPROM or battery backup for all variable data storage.

9. System design shall be modular.

10. All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal shall be provided.

11. System shall be capable of equipment runtime totalization of fans, heaters, boilers, etc. And capable of alarm generation and alarm dial out.

12. All hardware shall be listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916 in both the US and Canada, with integral labels showing rating.

13. All hardware shall be in compliance with FCC Part 15, Subpart J, Class A.

## 2.02 SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation.

1. Graphic Display. A graphic with a minimum of 20 dynamic points shall display with current data within 10 sec.

2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec.

3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.

4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.

5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 1 sec. Select execution times consistent with the mechanical process under control.

7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.

8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.

9. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 1.

Table 1 - Control Stability and Accuracy

| Controlled Variable | Control Accuracy | Range of Medium |
|---|---|---|
| Water Flow | ±2% of full scale | |
| Dew Point (note 1) | ±1.5ºF | |
| Water Temperature | ±1.2 ºF | |
| Airflow | ±5% of full scale | |
| Space Temperature | ±1.0ºF | |
| Duct Temperature | ±1.2ºF | |
| Fluid Pressure (note 2) | ±0.5 psi | |

NOTE 1: Accuracy applies to 10% - 90% of scale
NOTE 2: For both absolute and differential pressure
GENERAL NOTE - Sensors to be selected such that measured media is near middle third of sensor range

## 2.03 TEMPERATURE SENSORS

A. General

1. Sensors shall have a limited lifetime warranty.

2. All devices shall use precision thermistors unless stated to the contrary in this section.

3. Provide NEMA 1 termination box unless otherwise specified

B. Sensor Specifications

1. Space Sensors:

a) Standard Space sensor shall be available in an off-white enclosure for mounting in a standard electrical box. Mount at 48” height.

b) Sensors in public areas shall be provided without local temperature indication, setpoint adjustment or setback override.

c) Sensors in private / staff only areas shall be provided with local temperature indication, setpoint adjustment and setback override functions.

d) Where potentially subject to damage (stairwells, gyms, corridors) or as directed by the Owner or Engineer, provide bushed stainless steel blank wall plate type sensors.

e) Where space sensors are connected to dedicated terminal unit controllers, they shall be equipped with local communication interface for troubleshooting and balancing purposes. Provide all required wiring from the terminal controller to the space sensor to allow for interface to a local laptop interface device.

f) Wall Plate Sensors - Blank wall plate style sensors, Kele KTP3 Stainless Steel Flush Mounted Thermistor and RTD Sensors or approved equal. Provide only where specified or called out on project drawings

2. Duct Sensors:

a) Single point duct mounted sensors shall have a minimum 8" rigid probe and be used when the duct size is less than 24"or where duct stratification is not present, such as downstream of fans.

b) Averaging duct-mounted sensors shall have a minimum 8' long averaging element and be used when the duct size is greater than 24". Where multi-point thermistor averaging sensors are to be used, sensing element spacing not to exceed 16". Provide averaging sensors in all locations where specified or where temperature stratification can occur. Minimum element to be provided, 1 ft. per 2. sq ft of area. Securely support all elements to avoid movement in air stream or long term damage at stress / mounting locations. Supports shall provide radius bend support and insulation to avoid thermal bridging.

3. Well Sensors:

a) Liquid immersion sensors shall have a stainless-steel probe and a stainless steel or brass well. Length of the sensor well shall be selected based on the diameter of the pipe to provide accurate, reliable sensing of the liquid temperature.

4. Outside Sensors:

a) The sensing element shall mounted inside a ventilated, treated, sun shield to minimize the radiant energy and wind effects. Sensor location shall be selected to minimize effects from sunlight, building heat, exhaust systems, etc. Temperature Controls Contractor shall be responsible for selection of an appropriate location. Where sensor location is determined to be adversely affected by outdoor conditions, this contractor shall relocate the sensing devices to a more reliable position.

## 2.04 THERMOSTATS

A. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

B. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

**2.05 HUMIDITY SENSORS**

A. Duct and room sensors shall have a sensing range of 20%-80%, minimum accuracy of +/- 2% over this span.

B. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH, minimum accuracy of 2% over this span, and shall be suitable for ambient conditions of 0°F-140°F.

C. Humidity sensors shall not drift more than 1% of full scale annually.

D. Temperature compensation of RH reading.

E. Two-year warranty from date of installation.

**2.06 FLOW SWITCHES**. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service). Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).

A. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.

B. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

**2.07 RELAYS**

A. Control Relays. Control relays shall be UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

B. Time Delay Relays. Time delay relays shall be solid-state, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

**2.08 OVERRIDE TIMERS**

A. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

**2.09 CURRENT TRANSMITTERS**

A. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden.

B. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

C. Unit shall be split-core type for clamp-on installation on existing wiring.

**2.010 CURRENT TRANSFORMERS**

A. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

B. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.

C. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

**2.011 VOLTAGE TRANSMITTERS**

A. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

B. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden.

C. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

**2.012 VOLTAGE TRANSFORMERS**

A. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

B. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.

C. Windings (except for terminals) shall be completely enclosed with metal or plastic.

**2.013 POWER MONITORS**

A. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.

B. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

**2.014 CURRENT TRANSDUCER / EQUIPMENT INTERFACE RELAY**

A. Low voltage, single phase:

1. Combined status sensor, command relay, and hand-off-auto switch.

2. Sized for monitor and control of small motors.

3. Field selectable relay output.

4. High and low voltage isolation.

5. Industrial grade load switching relay.

6. Mountable on single or double gang boxes, flush on starter enclosures, or stand-alone.

7. Approved for installation in the following environmental conditions:

   a) 0-95% RELATIVE HUMIDITY, NON-CONDENSING.

   b) –15° TO 60° C

8. Design equipment: Veris Hawkeye H500 Series or approved equal.

9. Alternative components combining the total functionality of the specified device may be submitted for approval.

**2.015 PRESSURE TRANSMITTERS**

A. Pressure transmitters shall be of 2-wire, 4-20 mA / 0-10vdc output type with a capacitance element having an accuracy of +/- 1% over the entire range. Transmitter shall include protection against reverse polarity and supply voltage transients. Accuracy and zero span adjustment shall be provided with each transmitter to allow for recalibration as necessary.

1. LIQUID PRESSURE

a) The operating range shall be -40.0 to 176.0 F.

b) Safe overpressure shall be a minimum of 150% of the rated pressure.

c) Sensor range to be selected so anticipated control setpoint resides in the middle third of the sensor span.

d) Use of two discrete pressure sensors and mathematical determination of system differential pressure is acceptable.

e) Differential pressure sensor shall use a five-valve manifold to allow proper service and removal of air from the sensing lines without damage. Locate such that the lines from the primary piping can be properly drained and vented. Provide isolation at the mains to allow service to the assembly.

f) Shall be contained in an aluminum NEMA-1 enclosure.

2. Air Pressure

a) The operating range shall be 0 to 150.0 F.

b) Safe overpressure of 10psi.

c) Sensor shall be equipped with reverse polarity protection.

d) Accurate to within 1% over full scale

e) Sensor shall have ability for field zero of reading and output.

f) Bi-directional ranges available by application

g) Shall be contained in a NEMA-1 enclosure.

h) Not to be provided when Space Pressure Monitor (SPM) / Room Pressure Monitor (RPM) is specified or called out on the drawings.

i) Sensor warranty shall be 3 years.

j) Design Make – Setra 264 or approved equal

**2.016 DIFFERENTIAL PRESSURE SWITCHES**

A. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

**2.017 PRESSURE-ELECTRIC (PE) SWITCHES**. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).

A. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.

B. Switches shall be open type (panel-mounted). Exception: switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

C. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

**2.018 FLOW TRANSMITTERS**

A. Airflow – Velocity over 1000 fpm

1. Acceptable for use only in applications where duct velocity will be maintained over 1000fpm over entire operating range of equipment.

2. Air flow monitoring stations requiring the use of “air straighteners” are specifically prohibited.

3. Constructed of 16-gauge galvanized steel casing, extruded aluminum sensors and copper collectors. Measured velocity pressure converted to air flow shall have accuracy within + 2% of the full scale from 700 to 4000 fpm. Sized by manufacture, rectangular, round or oval for application. Provide with volume meter with actual flow display, mounted on adjacent wall. Interface with DDC controllers.

4. Acceptable Makes: Cambridge, Air Monitor, Paragon

B. Airflow – Acceptable for all applications

1. Duct mounted airflow measuring station shall consist of one or more airflow/temperature measuring devices based on size of duct and all required electronics. The complete system shall be factory tested prior to shipment. The airflow measuring station shall not require calibration over the life of the equipment.

2. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans without prior approval by the Engineer.

3. Each sensing point shall measure both airflow and temperature using a pair of instrument grade, hermitically sealed, glass encapsulated thermistors, one self-heated and one ambient temperature. Airflow rate sensing device shall utilize thermal dispersion technology. Individual sensor notes shall be individually calibrated at 16 points to NIST calibration standards. Sensors will read and system will compensate for air temperature and impact on velocity or CFM. Provide copy of NIST calibration report for the reference standard to calibration the production tunnels used to calibrate individual sensor nodes. Devices claiming AMCA certification are not acceptable.

4. Provide air flow measuring station transmitter including any 24 VAC transformer to interface with the BAS. Each measurement location shall produce a single, separate linear analog output signal for airflow and temperature where indicated, both of which can be directly interfaced to the BMS.

5. The system shall have the ability to perform self-diagnostics and produce an alarm, which can identify the source of malfunction. In the event of a sensor failure, the system shall ignore failed sensor(s), average remaining sensors and shall continue to operate.

6. Sensor range shall be minimum and maximum system airflow rates with an accuracy of ±2%. Sensors and electronics shall operate over a temperature range of -20° F to 120° F, acceptable for use over a range of 5-95% RH, non-condensing. Size for 125% of anticipated range of air flow. The number of independent sensing points shall be per manufacturer's recommendations for the specified application as shown on drawings.

7. Remote transmitters to be mounted in a location protected from moisture. Provide weatherproof enclosure and mount away from direct sunlight when outdoor mounting is required.

8. The probe body shall be constructed of extruded anodized aluminum alloy.

9. Provide a Bluetooth and Android/IOS software that allows real time airflow and temperature monitoring.

10. Provide required length of cable to location of adjacent transmitter station to be mounted in an accessible, convenient location for operator use. Prior to start-up, a factory trained representative shall visit the site to inspect installation of air flow measuring devices and wiring. A written report shall be submitted to the engineer for the start-up services.

11. Acceptable Make: Ebtron, Air Monitor

C. Fan Array and Single Fan Measurement.

1. For use only where specifically called for or approved in advance by the Engineer

2. Each AMD shall be suitable for installation in fan inlets to determine the airflow rate and velocity weighted temperature of the airstream.

3. Each sensing point shall measure both airflow and temperature using a pair of instrument grade, hermitically sealed, glass encapsulated thermistors, one self-heated and one ambient temperature. Airflow rate sensing device shall utilize thermal dispersion technology. Individual sensor notes shall be individually calibrated at 16 points to NIST calibration standards. Sensors will read and system will compensate for air temperature and impact on velocity or CFM. Provide copy of NIST calibration report for the reference standard to calibration the production tunnels used to calibrate individual sensor nodes. Devices claiming AMCA certification are not acceptable.

4. Provide face, forward mount adjustable brackets for each sensor node. Mount styles shall not affect the airflow or sound performance of plenum fans.

5. Provide air flow measuring station transmitter including any 24 VAC transformer to interface with the BAS. Each measurement location shall produce a single, separate linear analog output signal for airflow and temperature where indicated, both of which can be directly interfaced to the BMS.

6. Provide the following number of sensor nodes based on fan type. All sensors shall be connected to a single, remote transmitter. Fan array models shall calculate the airflow of each fan individually prior to outputting the total airflow rate and have a built-in alarm capable of removing a failed fan from the total airflow calculation.

   a) SWSI fans – Two

   b) DWDI Fans – Two per inlet

c) Fan Arrays – One per inlet

D. Liquid Flow

1. Insertion Type - Onicon F3500 or approved equivalent only

2. Install in compliance with all manufacturers requirements.

3. Provide type as specified on the contract drawings.

E. Remote Readout Unit:

1. Provide only where specified or shown on the drawings.

2. Able to accept signals from meter, temperature transmitter and pressure transducer.

3. Shall provide local display of actual flow rate, totalized flow (counter), and percent of full flow.

4. Shall provide a 4-20 mA DC analog signal to read actual flow and totalized flow at DDC controller.

5. 115V or 230V AC operation (+ 15%).

6. Provide in NEMA 4 enclosure. Mount on adjacent wall.

**2.019 VOC SENSORS**

A. Provide where specified or shown on the drawings

B. Contains calibration algorithm for correlation to CO2 concentration levels

C. Available as combination VOC / Temperature / Humidity sensor – coordinate with zone requirements.

D. Provide digital reading of VOC level and optional temperature and humidity.

E. Eighteen-month warranty from installation date

**2.020 ENCLOSURES**

A. Enclosures shall be NEMA-1 rated steel, finished to control oxidation in a highly humid atmosphere.

B. Each enclosure shall have a hinged door with handle and keyed lock

C. Shall provide 40% of free space for future expansion of the system.

**2.021 DAMPER MOTORS**

A. Electronic:

1. Electronic actuators shall be driven directly by 0-10 VDC, supply power: 24 VAC or 30VDC, as acceptable to its controller, and provide adequate torque to meet the application.

2. Where actuators over 30vdc requirement are supplied, coordinate with furnishing contractor for all wiring requirements in compliance with NEC and these specifications.

3. Electronic actuators shall be direct-coupled type.

4. For all actuators, assure execution of the fail-safe position in case of the Freezestat trip or power loss.

5. Actuators to be sized for smooth operation over entire range and a minimum of 150% of required torque for connected components.

6. Design Make: Belimo, Neptronic.

**2.022 CONTROL DAMPERS**

A. Rectangular;

1. Blades are extruded aluminum profiles. Aluminum end caps are press fitted to blade ends in order to seal hollow interior and reduce air leakage rates.

2. Blade and frame seals are extruded silicone and are secured in an integral slot within the aluminum extrusions.

3. Bearings are composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

4. Linkage hardware is installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

5. Dampers are designed for operation in temperatures ranging between -40°F (-40°C) and 212°F (100°C).

6. Dampers are available with either opposed blade action or parallel blade action.

7. Leakage class 1A at 1” w.g. Static pressure differential. Standard air leakage data is certified under the AMCA Certified Ratings Program.

8. Two position dampers - Pressure drop not to exceed 0.2”wc as installed. If frame is fully within the duct, the pressure drop calculations shall account for this installation method.

9. Modulating Control Dampers shall be sized by the temperature control manufacturer. Maximum velocity shall be 1500 fpm and maximum pressure drop shall be 0.15 in w.g, not to exceed 0.2”wc. Dampers shall be of adequate authority and sized and positioned to allow for smooth modulation of controlled air streams.

10. Damper pressure drops shall take into account the as-installed position and be certified for pressure drop per AMCA standard 500-d.

11. Dampers are available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct".

12. Provide thermally broken frame design where use of standard frame could cause condensation or operational issues.

13. Installation of dampers shall be in accordance with current manufacturer’s installation instructions.

14. Dampers over 48 in. In length and height shall be made into multiple sections.

15. Automatic dampers are required at all exterior walls and roof openings. Dampers to open when respective fan starts. Dampers at exterior walls and roof openings shall be insulated blade, thermal break design.

16. Design make: Tamco 1500 series (standard), Tamco 9000 series (outdoor air intake and exhaust / relief locations)

B. Round

1. Temperature Rating: Withstand maximum of 250 degrees F.

2. Minimum diameter 4 inches. Maximum 48 inch.

3. Capacity: Damper shall withstand HVAC system operating conditions:

4. Closed Position: Maximum pressure of 10 inches w.g @ a 6 inch diameter.

5. Open Position: Maximum air velocity of 4,000 feet per minute.

6. Leakage: Provide with damper blade seals. Maximum 10 cfm at 4 inches w.g. for 48 inch diameter damper.

7. Pressure Drop: Maximum 0.1 inch w.g at 1,000 feet per minute

8. Frame: Under 6 inch diameter; 2 inch x 12 gauge steel tube. 6 thru 12 inch, 2 inch x 0.5 inch x 14 gauge steel channel. Above 12 inch thru 24 inch, 2 x 0.5 x 1/8 inch steel channel. Above 24 inch; 2 x 1 x 3/16 inch steel channel.

9. Blade Style: Single skin round blade.

10. Material: Diameter 18 inch or under; 12 gauge steel. Diameter over 18 inch; 10 gauge steel (3.5 mm). Stiffeners as required.

11. Bearings: Stainless steel pressed into frame.

12. Seals: Neoprene ring.

13. Axles: Diameter 24 inch or under; 0.5 inch diameter plated steel. Diameter over 24 inch); 0.75 inch plated steel.

14. Actuation: Refer to Damper Actuators paragraph. Provide actuator mounting plate and extended shaft where required to allow proper insulation of duct insulation and damper actuator. Direct mount of actuator anti-rotation pin to the ductwork is not permitted.

15. Design Make: Ruskin CDR25

**2.023 CONTROL VALVES**

A. General:

1. Valves shall be applicable for the rated pressure and temperature service. Close off pressures must be determined in concert with the actuators and valves shall be provided to close off against extreme anticipated conditions. Valves shall be selected such that they are not, as a practice, “oversized.”

2. Modulating valves shall be carefully selected to control in a smooth and stable fashion across the range of anticipated conditions. “Split ranging” of heating and cooling valves controlled by the BMS is not acceptable. A separate output from the BMS shall be provided for all control valves. When the selection criteria indicated below are not met, flow characteristic analyses shall be submitted to demonstrate reasonable correlation between stroke and flow.

3. Modulating actuators for Primary Equipment (air handlers, etc.) shall be selected for smooth actuation over the entire operating range, use a 24vac power supply, and respond to an electronic input of: 4-20 mA or 0-10 VDC.

4. Actuators using “floating point” (bi-directional) for positioning shall be permitted on VAV box dampers and VAV reheat valves. Additional applications may be permitted with advance permission by the Engineer.

5. Pulse Width Modulation (PWM) actuators will be permitted on small unitary equipment, such as fan coils or other systems less than 1200cfm in size, but under no circumstances for use in control of outdoor air economizers or control valves greater than 1” in size. Additional applications may be permitted with advance permission by the Engineer.

B. Provide factory fabricated control valves with operators as required by this specification. Provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with specified maximum pressure drop across control valve. Equipment control valves with heavy duty actuators, with proper shut off rating for each individual application.

C. Valves shall be selected to perform as specified taking into account inlet and outlet piping geometry correction factors. Temperature control contractor shall instruct mechanical contractor on correct installation technique and verify that installation matches manufacturer’s requirements for proper performance.

D. Design Pressure Drop –

1. Water Service Valves - Unless specified to the contrary, valves shall be selected for a pressure drop approximately equal to that of the connected equipment, but no greater than 5 psi or less than 3 psi at design water flow.

E. Single Seated Valves:

1. Cage type trim, providing seating and guiding surfaces for plug on “top and bottom” guided plugs.

2. Valve Trim and Stems: Polished stainless steel.

3. Packing: Dual O-Ring up to 1 ½”, Spring-loaded Teflon, self-adjusting 2” and up.

4. Bodies, 2" and Smaller: Bronze with screwed end connections, replaceable brass seat. 125 psig rated, minimum

5. Bodies, 2 1/2" and Larger: Cast iron with flanged end connections, replaceable brass seat. 125 psig rated, minimum.

F. Ball Valves:

1. Modulating water valves shall be ball valves with an equal percentage characteristic.

2. Type: Two or three-way as called for, V-port ball valve with characterizing disk, 1/4 turn.

3. Packing: EPDM O-rings, lubricated.

4. Ball & Stem: Stainless steel.

5. Seat: Fiberglass reinforced Teflon.

6. Actuator: Electric, one motor only; valves 4 inches and larger shall have single operator.

7. Flow Characteristic: Equal percentage.

G. Actuator: Electric, one motor only

1. Failure positions shall generally be as follows, contact owner for special circumstances requiring deviation from these requirements:

a) Terminal hot water radiation: fail last

b) Fan Coil Unit cooling coils: normally closed spring return

c) Pre-Heat coils in air handling units: normally open spring return

2. Input signal: 0-10 VDC, equipped with spring failure position return all heating applications. "Floating point" actuation allowed only where specifically noted elsewhere in the contract documents.

3. The Back-to-back electronic actuations, i.e., where two identical actuators are engaged in operating the rising or rotation of valve stem are not permitted.

4. Valve Closeoff:

a) Water – 120% of total system (pump) head.

b) Valves to be used on this project shall be suitable for complete closeoff to the levels stated under modulating duty. In the event that manufacturer's data provides a separate maximum differential pressure under modulating duty, both criteria shall exceed the above requirements.

**2.024 SAFTEY/STATUS DEVICES**

A. Low Limit Detector ("freezestat"): Electric type, with manual reset and auxiliary contacts to the DDC, set for 37°F for "freeze" protection and 55°F for fan discharge application. Provide a 20' long element for every 25 sq. Ft. Of coil face area or fraction thereof. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

B. High Limit Detector ("firestat"): Electric type, with manual reset and auxiliary contacts to the DDC, UL Listed for fire, set for 180°F.

C. Fan status through adjustable range current sensing element on the fan motor. Calibrate to actual conditions.

**2.025 COMMUNICATIONS**

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Internet operator interface and value passing shall be transparent to network architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. System shall automatically synchronize system clocks daily from an operator-designated controller via the network. If applicable, system shall automatically adjust for daylight saving and standard time.

F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

## 2.026 OPERATOR INTERFACE

A. All operator workstation functions shall be updated on the existing operator workstation(s) to reflect the new equipment and systems installed under this project.

B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet.

C. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:

1. Log In and Log Out. System shall require user name and password to log in to operator interface.

2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.

3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, pid gains, on and off controls, and sensor calibration.

4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.

5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.

6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.

7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.

9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

D. System Software

1. Operating System. Workstation server shall operate on Microsoft Windows 10.

2. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

a) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

b) Animation. Graphics shall be able to animate by displaying different image files for changed object status.

c) Alarm indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

d) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

e) Provide a link from each piece of graphically represented equipment to the associated wiring diagram and sequence of operation.

E. System tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

3. System Configuration. Operators shall be able to configure the system.

4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.

5. Security. System shall require a user name and password to view, edit, add, or delete data.

    a) Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.

    b) Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.

    c) Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object.

8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.

9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.

10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.

11. Trend Configuration. Operator shall be able to configure trend sample or change of value interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk.

12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.

13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.

14. Standard Reports. Furnish the following standard system reports:

    a) Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.

    b) Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.

c) Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:

(1) Alarm History.

(2) Trend Data. Operator shall be able to select trends to be logged.

(3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

15. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.

16. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

17. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language (or block language equivalent) shall have the following features:

a) Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.

b) Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

c) Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

d) Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.

e) Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.

(1) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.

(2) System Variables. Operator shall be able to use predefined variables to represent status and results of controller software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

**2.027 CONTROLLER SOFTWARE**

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

B. Scheduling. System shall provide the following schedule options as a minimum:

1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).

2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule, has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.

3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

C. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

D. Alarm Reporting.

E. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms.

F. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits.

G. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

H. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

I. Startup Optimization – All equipment noted in the sequences of operation to have scheduled operation shall be started on an optimized basis which attempts to reach occupied conditions just prior to the scheduled occupancy time.

J. Pressure control optimization – All equipment noted in the sequences of operation (fans and pumps) shall have reset of pressure control setpoint initiated in the sequence. Typically, for pumps this would cause the software to examine all connected control valves for position, determine the critical valve (defined as the valve at the highest demand position), and reset the pressure setpoint up or down to maintain the critical valve between 80 and 90% open. For fans serving zone air valves / VAV boxes, this would similarly reset the duct pressure setpoint to maintain the critical zone damper between 80 and 90% open.

K. Energy Calculations.

1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.

2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

L. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

M. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

N. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified.

## 2.028 CONTROLLERS

A. General. Provide controllers and accessory devices as required to achieve performance specified.

B. BACnet.

1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.

2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135, and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.

5. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

6. BACnet Communication.

a) Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.

b) BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.

c) Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

d) Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

e) Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

f) Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.

2. Signal Management – Master or Global Controller operating systems shall manage input and output communication signals to allow distributed controllers (lower level networks) to share real and virtual object information and to allow for central monitoring and alarms.

3. Data Sharing. Each Master or Global Controller shall share data as required to allow the specified performance and sequence of operation.

4. Stand-Alone Operation. Each piece of equipment specified shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

E. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

F. Serviceability

1. Controllers shall have diagnostic LEDs for power, communication, and processor.

2. Wires shall be connected to a field-removable modular terminal strip or to a termination card to allow service without rewiring the controller.

3. Each controller shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

G. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 hz and from keyed radios up to 5 W at 1 m (3 ft).

H. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

## 2.029 INPUT AND OUTPUT INTERFACE

A. General. Hard-wire input and output points to all controller hardware.

B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

## 2.030 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

    a) Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

    b) Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering

1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:

a) Dielectric strength of 1000 V minimum

b) Response time of 10 nanoseconds or less

c) Transverse mode noise attenuation of 65 dB or greater

d) Common mode noise attenuation of 150 dB or greater at 40-100 Hz

## PART 3 - EXECUTION

### 3.01 WIRING

A. All wiring shall comply with these specifications, Specification Section 230514, and the NEC. Deviations are only permitted where manufacturer's requirements specifically conflict with gauge and wiring type specified within this section.

B. Communication wiring shall be installed using the particular system recommended, plenum rated, jacket shielded cable. The communication network wiring shall be clearly marked with a specific color code. Communication wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc. Communication wiring shall comply with the optimum requirements necessary to assure communication integrity and speed.

C. All analog inputs and analog outputs shall be wired using 18 gauge stranded shielded cable. All Analog inputs and analog outputs wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc.

D. All digital outputs shall be wired using 18 gauge stranded wire.

E. All wiring in mechanical rooms, walls shall be installed in EMT conduit. Concealed conduit and wiring is required in all finished spaces.

F. Power Supplies

1. Transformers – Each w/ low voltage fuse holder/disconnect

2. Actuators and relays shall use separate transformers from those powering microprocessor control panels.

3. Transformers shall be sized for a minimum of 150% of the connected load.

4. Convenience Outlet –

a. 110vac combination outlet w/ switch to kill 110vac to panel

5. Switched 110vac to panel is fused before transformers (after outlet).

6. Provide at all control panels excepting those for terminal equipment (exclude reheats, cabinet heaters, fan coils, etc.)

7. Wiring Panduit

    a. Wire ducts around exterior of panel for cables entering panel

    b. Wire ducts as necessary to route hookup wires from terminals to controllers and other devices

8. Panel Construction (sized to provide 25% future expansion w/ removable back panel)

    a. Indoors – Johnson M8100 series

    b. Outdoors – Hoffman fiberglass Nema 4x

9. Wire Labeling

    a. All DDC system wiring shall be individually labeled and permanently tagged at both ends of the conductors, including within all junction boxes between panels.

    b. All submittal and as-built drawings shall reflect the field installed wire tag numbers.

    c. All wire numbers shall be unique throughout the system installation.

**3.02 DDC EQUIPMENT**

A. All components and controllers shall be installed in protective enclosures. All wiring within the DDC enclosure shall be number coded. Both the enclosure and the controller shall be properly grounded in accordance with manufacturer's recommendation. Documentation shall be firmly attached to the enclosure within a plastic envelope. Documentation shall state point-to-point termination detail, description of each individual point, location of power source for the controller and ID number or address within the network.

B. All DDC Controllers shall be mounted on walls within equipment rooms, custodial closets or electrical rooms. Only application-specific controllers for rooftop units or package units may be mounted on the equipment.

**3.03 EXAMINATION**

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.

B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate work of others. Temperature Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

**3.04 PROTECTION**

A. Temperature Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.

B. Temperature Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

## 3.05 COORDINATION

A. Site.

1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.

2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance.

1. Furnish Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing for the duration of TAB activity

2. Train Test and Balance Contractor to use control system interface tools.

3. Provide a qualified technician to assist with testing and balancing of all air handling equipment and terminal units.

4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

C. Life Safety.

1. Duct smoke detectors required for air handler shutdown are furnished and installed by others. Interlock smoke detectors to air handlers for shutdown as specified Sequence of Operations for HVAC Controls.

2. Smoke dampers and actuators required for duct smoke isolation are furnished and installed by others. Interlock smoke dampers to air handlers as specified in Sequence of Operations for HVAC Controls.

D. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.

1. Each supplier of a controls product shall configure, program, start up, and test that product to meet the required sequences of operation regardless of where within the contract documents those products are described.

2. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.

3. Temperature Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

## 3.06 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

B. Independently support all temperature control wiring from other systems. Do NOT support from conduits, piping or hangers for equipment.

C. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

D. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

E. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

F. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

## 3.07 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.

B. Continually monitor field installation for code compliance and workmanship quality.

C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

## 3.08 COMMUNICATION WIRING

A. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

B. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

C. Verify entire network's integrity following cable installation using appropriate tests for each cable.

D. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

E. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

F. Label communication wiring to indicate origination and destination.

## 3.09 INSTALLATION OF SENSORS

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment.

C. Install room temperature sensors on concealed junction boxes properly supported by wall framing. Where sensor locations can be effected by wall surface temperature, pack junction box with insulation and provide insulated back plate for sensor. Install all space sensors so they are not affected by direct sunlight, appliances / equipment, or air currents. Consult with the Engineer prior to installing device if the location shown on the project drawings does not meet these criteria.

D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas. Use of Silicon or similar sealant is prohibited. Use Fiberglass or poly fill in the junction boxes.

E. Use averaging sensors in mixing plenums and hot and cold decks, and all duct locations which may be subject to stratification. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a mechanically fastened capillary clip. "Stick on" type fasteners are specifically prohibited.

F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a mechanically fastened capillary clip. "Stick on" type fasteners are specifically prohibited.

G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells. Sensors and wells shall be installed to assure that the entire sensing element is completely immersed in the measured media with minimal pressure drop. Provide oversized pipe section, oversized elbow, or other recognized method to achieve this result in compliance with this specification and manufacturer's recommendations.

H. Install outdoor air temperature sensors on north wall with sun shield. Sensor to be located where thermal characteristics of the building and solar load do not effect readings.

I. All sensors to be mounted on externally insulated ductwork or plenums shall be provided with standoff brackets. Insulation and vapor barriers shall be carried continuously beneath the sensor enclosure. Coordinate installation with mechanical and insulation contractors.

J. Differential Air Static Pressure.

1. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.

2. Air pressure transducers - mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.

3. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status. Interlock shall be provided such that the unit cannot be restarted in either hand or auto modes without manual reset of the safety device.

**3.010 FLOW SWITCH INSTALLATION**

A. Use correct paddle for pipe diameter.

B. Adjust flow switch according to manufacturer's instructions.

**3.011 FLOW TRANSMITTER INSTALLATION**

A. Airflow and Liquid Flow

1. Provide meter probe size, type and arrangement per manufacturers recommendations to obtain accuracy and performance specified.

2. Verify calibration of Remote Readout Unit (where specified to be provided) over operating range in conjunction with TAB contractor. Perform all necessary field calibration to obtain readout accuracy within specified limits.

3. Provide specified interface to DDC system.

4. Verify accuracy of DDC system reading against Remote Readout Unit (where specified) and balancer readings over operating range of device.

5. Provide installation in strict compliance with manufacturer's requirements.

### 3.012 ACTUATORS

A. General. Mount actuators and adapters according to manufacturer's recommendations.

B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.

1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.

2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.

3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

4. Provide necessary mounting hardware and linkages for actuator installation.

C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

D. Where actuators are mounted to the side of insulated ductwork or equipment, provide insulation standoffs and repair insulation and vapor barrier.

### 3.013 CONTROL VALVE INSTALLATION

A. Control valves to be installed in strict compliance with manufacturer's requirements.

B. A minimum of 3 straight pipe diameters shall be provided at the inlet, and 2 at the outlet of all control valves. Pipe to be of the identical size as valve body inlet and outlet. Where reducers are provided to adapt pipe size to valve body size these shall be located approximately 3 pipe diameters upstream of pipe inlet (s) and 2 diameters downstream of the outlet. These values may be reduced or adjusted so long as final installation complies with manufacturer's requirements.

C. The contractor is responsible for verifying valve porting to conform to system requirements. If direction is required to assure correct operation, it is the responsibility of this contractor to contact the Engineer clarify design intent.

D. For heating water and steam systems – where conditions permit, the actuator shall be canted 45 degrees from vertical such that the actuator is not directly above the pipe.

### 3.014 WARNING LABELS

A. Affix permanent warning labels to equipment that can be automatically started by the control system.

1. Labels shall use white lettering (12-point type or larger) on a red background.

2. Warning labels shall read as follows.

| C A U T I O N |
| --- |
| This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing. |

B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows.

| C A U T I O N |
| --- |
| This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing. |

**3.015 IDENTIFICATION OF HARDWARE AND WIRING**

A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 2 in. of termination.

B. Permanently label or code each point of field terminal strips to show instrument or item served.

C. Label control panels with minimum ½ in. letters on laminated plastic nameplates.

D. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

E. Label room sensors related to terminal boxes or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

G. Label identifiers shall match record documents.

H. Provide laminated control diagrams in each control panel for each piece of major controlled equipment or system.

**3.016 OPERATOR INTERFACE**

A. Standard Graphics. Provide graphics as specified. Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List / diagram. Point information on graphics shall dynamically update.

B. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation).

C. Provide logical descriptions and engineering units on all data displays. Example: percentage position shall be easily discernable as percent open or closed.

D. Provide logical linking between graphics. For example, direct penetration from building to floor to air handler to air terminal and back is to be provided without need to resort to a menu tree to navigate the building.

E. Graphical user interface shall be reviewed by the Owner and / or Engineer. If in their sole opinion the graphics are inaccurate, incomplete, or improperly represent the systems, the graphics shall be updated as no additional cost to the project.

**3.017 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE**

A. Prior to demonstration and acceptance, the contractor shall:

1. Complete all Pre-Commissioning requirements as described in paragraph 1.11 of this section.

2. Complete system commissioning requirements per section 019113.

3. Correct all deficiencies in control system hardware and software noted in engineer's punchlists, field observations, and commissioning issues logs / reports.

B. Demonstration. Prior to acceptance, perform the following to demonstrate system operation and compliance.

1. Engineer and / or Owner's representative will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.

2. Demonstrate actual field operation of sequence of operation. Provide at least two persons equipped with two-way communication (if required). Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation. Engineer may, at their discretion, perform these tests on a "spot check" basis.

3. Demonstrate complete operation of operator interface.

4. Demonstrate each of the following.

a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.

b. Demand limiting (where applicable). Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.

c. Building fire alarm system interface.

d. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation.. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.

5. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

C. Acceptance.

1. After tests described in these specifications are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control, such as seasonal requirements or construction progress issues. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

### 3.018 CLEANING

A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.

B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

B. Provide all chemical treatment required for piping systems each time an individual system is drained and then refilled as a result of work performed under this contract.

## 1.02 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

## 1.03 SUBMITTALS

A. Provide submittal documentation for the following:

1. Schedule of pipe materials, fittings and connections by piping system.

2. Piping materials, fittings and appurtenances to demonstrate compliance with the requirements of this section.

3. Piping accessories

4. Anchors, sleeves, hanger shields, and guides.

## 1.04 QUALITY ASSURANCE

A. Manufacturer: Provide domestically manufactured pipe, fittings and accessories.

B. All pipe, tubing and fittings shall be either tested by an approved third party testing agency or certified by an approved third party certification agency.

## 1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver products in factory-fabricated containers. Deliver pipe and tube with factory-applied plastic end-caps on each length.

B. Store products in original wrapping and protect from dirt and damage. Store piping and tube inside. Where necessary to store outside, evaluate well above grade and enclose with waterproof wrapping.

C. Handle products carefully to avoid damage. Do not install damaged products.

# PART 2 - PRODUCTS

## 2.01 GENERAL

A. Each length of pipe and each pipe fitting shall be new and marked with manufacturer's name; complying with the following Standards where applicable:

1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

2. American Society of Mechanical Engineers (ASME)

3. American Society of Testing and Materials (ASTM)

4. American National Standards Institute (ANSI)

5. American Water Works Association (AWWA)

6. American Petroleum Institute (API)

7. American Standards Association (ASA)

B. Refer to the MCNYS section 1202 for additional compliance standards for piping and fittings.

C. Refer to the MCNYS section 1210 for piping requirements specific to ground source Heat Pump Loops.

**2.02 STEEL PIPING AND FITTINGS**

A. Pipe: ASTM A53, ASTM A106, Schedule 40 or Schedule 80 weight as specified as Exhibit "A"; black or galvanized finish as specified in Exhibit 'A' or as noted on drawings; ends chamfered for welding or roll grooved for grooved mechanical connections. Galvanizing on piping shall be in compliance with ASTM A123.

B. Fittings: Same material and pressure class as adjoining pipe.

1. Welded fittings: Same weight as adjoining piping, factory forged, seamless construction, butt weld type, chamfered ends, in compliance with ASTM A105, ANSI/ASME B16.9 and MSS SP-43. Socket weld, Class 3000, forged in compliance with ASTM A105 and ASME B16.11. Where branch connections are two or more sizes smaller than main size, "Weldolets", Class 3000, forged, in compliance with ASTM A105, ANSI/ASME B16.9 and MSS SP-97, "Threadolets", Class 3000, forged, in compliance with ASTM A105, ASME B16.11, ANSI/ASME B1.20.1 and MSS SP-97. Sockolet weld type, Class 3000, forged in compliance with ASTM A105, ASME B16.11 and MSS SP-97 where specified in Exhibit 'A'.

2. Screwed fittings: Malleable iron, black or galvanized, as called for in Exhibit 'A' or as noted on the Drawings. Fittings shall be in compliance with ASTM A197, ANSI/ASME B1.20.1 and ASME B16.3. Galvanizing of fittings sha1l be in compliance with ASME A153.

3. Malleable iron fitting shall be Standard Class 150 unless otherwise specified in Exhibit 'A' to be Extra Heavy Class 300.

4. Mitered elbows, "shaped" nipples, and job fabricated reductions are not acceptable unless specifically called for.

C. Flanges, Unions and Couplings:

1. Unions: For sizes 2 in. and smaller - Malleable iron, bronze to iron seat, Class 300 in compliance with ASTM A197, ANSI/ASME B1.20.1 and ASME B16.39, or Class 3000 forged steel, steel to steel ground joint to ASTM A181, ANSI/ASME and B1.20.1. MSS SP-83 as called for in Exhibit 'A'. Galvanizing on the unions sha1l be in compliance with ASME A153.

2. Flanges: For sizes 2-1/2 in. and larger pipe sizes - Welding neck type, forged, in compliance with ASTM A105 and ASME B16.5. Class 150 or Class 300 as called for in Exhibit 'A'.

3. Flange Gaskets: All flange gaskets shall be Flexitallic Thermculite Type 835 Spiral Wound.

D. Cleanouts, gauge and instrument connections, nipples and plugs, for adapting gauges and instruments to piping system shall be IPS brass.

E. Base Elbows:

1. Cast iron or steel type, flange connections; Crane 500 or equivalent. Made from welding elbows, with welded pipe support and steel base. Reducing elbows where necessary.

| Elbow Size | Support Size | Base Plate |
|---|---|---|
| To 3 in. | 1-1/4 in. | 6 in. x 6 in. x 1/4 in. |
| 4 in. to 6 in. | 2-1/2 in. | 8 in. x 8 in. x 1/4 in. |
| 6 in. and larger | 6 in. | 14 in. x 14 in. x 5/16 in. |

2. Anchor bolt holes in each corner of base for securely bolting to floor or concrete base; minimum 3/4 in. bolts.

## 2.03 COPPER PIPE, SOLDER FITTINGS

A. Tubing (Type K, L or M "pipe"): Hard temper meeting in compliance with ASTM B75 and ASTM B88; Type K, L, M. as called for in Exhibit 'A' or as noted on the Drawings. Soft temper only as called for in Exhibit 'A' or as noted on the Drawings. Plans show copper tube sizes.

B. Tubing (DWV): Hard tempered, seamless copper, in compliance with ASTM B306.

C. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast bronze as called for in Exhibit 'A' or as noted on the Drawings; solder end connections; shall meet applicable and applicable ASME B16.22 or ASME B16.18.

D. Fittings (Tees, Elbows, Reducers, etc.): Cast bronze, threaded end connections, in compliance with ASME B16.15 and ANSI/ASME B1.20.1.

E. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast copper alloy drainage fitting (DWV), solder end connections, in compliance with ASME B16.29 or ASTM B23.

F. Unions and Flanges: 2 in. and smaller use unions, solder type, cast copper alloy or wrought copper alloy, metal to metal meeting surface, 150 lb. swp, in compliance with ASME B16.18 or ASME B16.22, ANSI/ASME B1.20.1. For piping 2-1/2 in. and over use flanges, cast copper alloy, companion type, Class 150, in compliance with ASME B16.24.

G. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel.

1. Make: Harris "Stay-Safe 50" and "Bright", Englehart "Silverbright 100", Willard Industries "Solder Safe (silver bearing), Canfield "Watersafe".

## 2.04 DRAINAGE PIPE AND FITTINGS

A. Tubing (DWV): Hard tempered, seamless copper, in compliance with ASTM B306.

B. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper drainage fitting (DWV), solder end connections, in compliance with ASME B16.29.

C. Unions: Solder type, cast copper alloy or wrought copper alloy, metal to metal meeting surface, in compliance with ASME B16.18 or ASME B16.22, ANSI/ASME B1.20.1.

D. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel.

1. Make: Harris "Stay-Safe 50" and "Bright", Englehart "Silverbright 100", Willard Industries "Solder Safe (silver bearing), Canfield "Watersafe".

## 2.05 COPPER PIPE AND BRAZED FITTINGS

A. Tubing (Type K, L): Hard temper in compliance with ASTM B75 and ASTM B88. As called for in Exhibit 'A' or as noted on the Drawings.

B. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast bronze as called for in Exhibit 'A' or as noted on the Drawings; solder end connections; shall meet applicable and applicable ASME B16.22 or ASME B16.18.

C. Unions and Flanges: 2 in. and smaller use unions, solder type, cast copper alloy or wrought copper alloy, metal to metal meeting surface, 150 lb. swp, in compliance with ASME B16.18 or ASME B16.22, ANSI/ASME B1.20.1. For piping 2-1/2 in. and over use flanges, cast copper alloy, companion type, Class 150, in compliance with ASME B16.24.

D. Brazing Materials: Silver Alloy, Airco Sil-4S or Sil-Fos as called for in Exhibit 'A' or as noted on the Drawings.

## 2.06 DIELECTRIC PIPE FITTINGS

A. Tensile strength, ASME B16.8 union 250 psi, or flange design, 175 psi, pressure rating, threaded or solder joint, constructed to prevent gasket from squeezing into internal opening.

B. Make: Capitol Manufacturing, Epco, Watts, Victaulic.

## 2.07 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps: Carpenter and Patterson, Central Iron, Fee and Mason, ITT Gruvlok.

B. Hangers:

1. Adjustable, wrought malleable iron or steel. Copper plated or PVC coated where in contact with copper piping. Cadmium plated or galvanized for exterior.

2. Adjustable ring type where piping is installed directly on hanger for piping 3 in. and smaller.

3. Adjustable steel clevis type for piping 4 in. and larger, and where insulation passes through hanger.

4. Steam (over 50 psi) piping, adjustable yoke pipe roller equivalent Gruvlok.

5. Hangers sized to permit passage of continuous insulation through the hanger.

6. Nuts and rods with electroplated zinc or cadmium (0.005 in. minimum) finish.

C. Hanger Shields:

1. Pre-insulated type:

a) To be used where direct firm support and / or load restraint of piping system required while insulation system maintained. Includes, but not limited to riser clamps, pipe guides and seismic restraint points. May be used for general support at hanger or trapeze locations at contractor option.

b) To be used where anticipated pipe surface temperatures may exceed 800 degrees on a consistent basis.

c) Insulated pipes shall be protected at point of support by a 360° insert of high density, 100 psi waterproofed calcium silicate, encased in a 360° sheet metal shield. Insulation insert to be same thickness as adjoining pipe insulation and extend 1 in. beyond sheet metal shield.

2. Field-insulated type:

a) #18 USSG, galvanized steel shields, minimum 120° arc. Provide temporary blocking between pipe and hanger to maintain proper spacing for insulation. Provide at all support points.

3. Shield Sizing:

| Pipe Size | Shield ID (1 ½" insulation) | Shield Length | Minimum Gauge |
|---|---|---|---|
| Up to 3-1/2" | Up to 6.5" | 12 in. | 18 |
| 4" | 7" | 12 in. | 16 |
| 5" and 6" | 8" and 9" | 12 in. | 14 |
| 8" to 14" | 11" to 17" | 24 in. | 12 |
| 16" to 24" | 19" to 27" | 24 in. | 10 |

a) Hanger shield gauges listed are for use with band type hangers only. For point loading (roller support), increase shield thickness by one gauge, and length by 50%.

D. Spacing Schedule: Hanger spacing shall be per the following tables. For alternate materials and sizes not listed herein, refer to the MCNYS, Section 305

| Pipe Size | Steel | Copper | PVC Plastic | Rod Size |
|---|---|---|---|---|
| ½ to 1 in. | 8 ft. | 6 ft. | 3 ft. | 3/8 in. |
| 1 ¼ to 2 in. | 10 ft. | 6 ft. | 3 ft. | 3/8 in. |
| 2 ½ to 4 in. | 12 ft. | 10 ft. | 4 ft. | 1/2 in. |
| 5 and 6 in. | 12 ft. | 10 ft. | 4 ft. | 5/8 in. |
| 8 in. | 12 ft. | 10 ft. | 4 ft. | 3/4 in. |
| Over 8 in. | To suit loading conditions | | | |

E. Inserts: Provide high density fiberglass or calcium silicate piping inserts to eliminate compression of pipe insulation system, full length of specified piping shield, by pipe size.

1. Make: "H-Block" by ICA, Inc., TPS / TPSX by SPI, or approved equal.

F. Supports:

1. For weights under 1000 lbs.: "Drill-In" inserts equivalent to Phillips "Red Head," "U-Channel," "Unistrut," beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.

2. For weights above 1000 lbs.: Drill through floor slabs and provide flat flush plate welded to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs. The factor of safety shall be at least four.

3. For metal decks: Drill hole through for hanger rods and imbed a welded plate in concrete or use Phillips "Red Head" devices designed for this application, with a safety factor of four.

## 2.08 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast iron polished chrome, split hinge type with setscrew, high plates where required for extended sleeves.

B. Pipe Guides: Cylindrical steel guide sleeve, proper length for travel, integral bottom base anchor; top half removable. Split steel spider to bolt to pipe, copper plated spider for copper pipe. Space between sleeve and spider to allow for insulation where required. Make: Anaconda, Flexonics, Pipe Shields, Keflex, or equal.

C. Anchors: Same material as pipe. Make: Keflex, Flexonics, Pipe Shields, or field constructed.

D. Pipe Roll Stand: Cast iron roll stand. Make: Advanced Thermal Systems, Carpenter and Patterson, ITT Gruvlok, Pipe Shields.

## 2.09 SLEEVES

A. Standard Type:

1. Schedule 40 black steel pipe sleeves, two pipe sizes larger than the pipe, for structural surfaces (bearing walls, structural slabs, beams and other structural surfaces) and where called for.

2. Schedule 40, PVC sleeves or sheet metal sleeves for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18 gauge minimum and braced to prevent collapsing.

B. Pre-Insulated Type:

1. Adjustable or fixed length metal cans, 24 gauge minimum, sized for 1 in. spacing between insulation and can. Insulation shall consist of a 360$^{o}$ waterproofed calcium silicate insert sized to extend 1 in. beyond wall or floor penetration. Calcium silicate insert shall be same thickness as adjoining pipe insulation. Spacing between shield and can packed at each end with double neoprene coated rope positively fastened. To be used where specified and at all locations where pipe surface temperature may exceed 500 degrees.

## 2.010 SEALING ELEMENTS

A. Waterproof Type:

1. Exterior walls, below grade, above floor: Synthetic rubber material with zinc plated bolts.

2. Acceptable Make: "Link-Seal" Series 200, 300 or 400, Pyropac, Calipco.

## 2.011 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL/FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Through-Penetration Firestop Systems". The system shall meet the standard fire test for Through-Penetration Firestop Systems designated ASTM E814. Firestop system seals shall be provided at locations where piping passes through fire rated wall, floor/ceiling, or ceiling/roof assembly. Minimum required fire resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform to the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

## 2.012 PIPING MATERIALS AND SCHEDULE

A. See Exhibit "A," "Schedule of Piping Materials" at end of this Section for (HVAC) piping.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leak proof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate accessible unions and flanges for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, with 1/16" misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as indicated or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 1.0" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Wherever possible, in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Space pipe supports, arrange reducers, and pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low points, and wherever required to permit complete draining of all lines.

D. Make all changes in size and direction of piping with fittings, except for soft copper tubing, use tubing bender.

E. Install piping to valves, strainers, pumps and other equipment at full line size. Where reduction or increase in size is required, make it with a fitting at the equipment connection.

F. Air Vents: Provide manual air vents at high points in piping system and where indicated on the drawings.

G. Drain Valves: Provide manual drain valves at low points in piping system and where indicated on the drawings.

### 3.02 EQUIPMENT AND SYSTEMS

A. Equipment and systems in accordance with laws, codes, and provisions of each applicable section of these specifications. Accurately establish grade and elevation of piping before setting sleeves. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring. Arrange piping at equipment with necessary offsets, unions, flanges, valves, to allow for easy part removal and maintenance. Offset piping and change elevation as required for coordination with other work. Avoid contact with other mechanical or electrical systems. Provide adequate means of draining and venting units, risers, circuits and systems. Conceal piping unless otherwise called for. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation. Make changes in direction and branch connections with fittings. Do not install valves, unions and flanges in inaccessible locations. Provide trap seal of adequate depth on drain pans.

### 3.03 WATER SYSTEMS

A. Top connection for upfeed, bottom or side connection for downfeed. Grade off-level; up in direction of flow and down toward drain.

## 3.04 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, vertical expansion bolts or from other piping. Support each pipe with individual hangers from concrete inserts, welded supports, or beam clamps of proper configuration and loading design requirements for each location. Trapeze hangers are acceptable for racking of multiple pipes of 1-1/2" or less in size. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing and of size as called for, using four nuts per rod. Provide additional rust proofed structural steel members, where required for proper support. Provide oversized hangers where insulation/supports must pass between pipe and hanger. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible on joists; "C" type not permitted on joists. Provide riser clamps for each riser at each floor.

## 3.05 PIPE CONNECTIONS

A. Solder Connections: Utilize non-acid flux and clean off excess flux and solder. Flux conforming to ASTM B813 shall be used in conjunction with solder conforming to ASTM B32.

B. Brazed Connections: Make joints with silver brazing alloy in accordance with manufacturer's instructions. Remove working parts of valves before applying heat. "Walseal" fittings may be used; if insufficient alloy is showing, face braze such joints. Filler material shall conform to AWS A5.8

C. Threaded Connections: Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be specific for each application. Threads shall conform to ASTM B.1.20.1.

D. Dielectric Pipe Fittings: Provide dielectric unions at all equipment connections where dissimilar metals meet. In addition, provide dielectric unions in all open type piping systems (condensing water, domestic water, etc.) where dissimilar metals are to be joined.

## 3.06 WELDING

A. Welding shall be performed in compliance with the welding procedure specifications prepared by the National Certified Pipe Welding Bureau. Welded piping shall be fabricated by certified welder. Contractor shall submit proof of current certification of each welder, if requested by Owner. Use full length pipe where possible; minimum distance between welds shall be 18 in. on straight runs. Welds must be at least full thickness of pipe with inside smooth and remove cutting beads, slag and excess material at joints; chamfer ends. Minimum gap 1/8 in., maximum 1/4 in., for butt welds. Overlaps on position and bench welds to be not less than 3/4 in. One internal pass and one external pass minimum required on slip-on flanges. Do not apply heat to rectify distorted pipe due to concentrated welding; replace distorted pipe. Welding is prohibited in existing building, except in the following areas: boiler rooms, mechanical rooms, crawl spaces and roof decks**.** When welding galvanized pipe, apply cold galvanizing on joint after welding.

## 3.07 HANGER SHIELDS

A. Pre-insulated type or field-insulated type at Contractor's option.

B. Provide for all chilled water and all "non-direct" connection supports.

## 3.08 SLEEVES

A. Provide for pipes passing through floors, roofs/decks, walls or ceilings.

B. Pre-insulated type: Required for chilled water piping.

C. Standard type: Provide for piping as noted above. Extend 1/8 in. above finished floor in finished areas. In above grade mechanical rooms and other areas with floor drains; use steel pipe sleeves projecting 2 in. above floor. Sleeves shall be as small as practical, consistent with insulation, to preserve fire rating. Fill abandoned sleeves with concrete. Where necessary for pipes to pass through ducts, air chambers or built-up housings and approved by Engineer, provide rubber grommet seals.

D. Roof/deck penetrations: Provide sleeve and deck sealing for watertight installation per detail on Contract Documents.

E. Provide a 0.16 inch thick smooth aluminum jacket over insulated pipes where they pass through sleeves.

**3.09 ANCHORS AND GUIDES**

A. Provide piping system anchors and guides as shown on the plans, and as recommended by the expansion joint/loop manufacturer. Where an anchor is shown at a change in piping direction, it shall fully control movement in all three axes. In lieu of a single anchor fabricated for two directional pipes, two (2) individual anchors may be provided.

**3.010 SLEEVE PACKING**

A. Seal void space at sleeves as follows:

B. Interior locations: Firmly pack with fiberglass and caulk.

C. Exterior walls and below grade cored holes: Use sealing element.

D. Fire rated, partitions and floor slabs: Use fire rated sealing elements, materials and methods. Provide per manufacturer's instructions to maintain firestop.

E. Vapor Barriers – provide continuity of vapor barriers through sleeves.

F. Waterproofed floors: Use waterproof sealing element, device, or compound.

**3.011 ESCUTCHEON PLATES**

A. Provide polished chrome escutcheon plates for exposed piping passing through floors, walls or ceilings, except in Boiler, Fan and Mechanical Rooms.

**3.012 TESTS**

A. Test piping and accessories before insulation, connecting to existing piping, and concealment. Repeat as many times as necessary to prove tight system. Notify Owner's Representative at least seven days in advance of each test. Isolate valves and equipment not capable of withstanding test pressures. Make leaks tight; no caulking permitted. Remove and replace defective fittings, pipe or connections. Furnish necessary pumps, gauges, equipment, piping, valving, power and labor for testing. Certify that test have been successfully completed.

B. Schedule of Test Requirements:

1. Hot water: Hydrostatic, 100 psig at high point of system; two hours duration.

2. Vent, drain, overflow and condensate drain: Hydrostatic, maintain 10 feet head of water above highest point of section being tested for six hours.

3. Tests: No change in pressure under stable temperature conditions.

4. Equipment: Test at working pressures.

### 3.013 PIPE LINE SIZING

A. Pipe sizes called for shall be maintained. Pipe size changes shall be made only as reviewed by Owner's Representative. Where discrepancy in size occurs, the larger size shall be provided.

**EXHIBIT 'A' – PIPING MATERIALS (HVAC)**
Notes are at the end of Exhibit 'A'

| SERVICE | PIPE MATERIALS | FITTINGS | CONNECTIONS |
|---|---|---|---|
| Hot water heating | Schedule 40, black steel | Malleable iron and butt weld | 2 in. and smaller screwed<br>2-1/2 in. and larger welded<br>SEE NOTE 1 |
| Hot water heating (Optional) | Type L copper | Wrought copper or cast bronze, solder end | 2 in. and smaller:<br>No-lead solder |
| Chilled water | Schedule 40, black steel | Butt weld and malleable iron | 2-1/2 in. and larger welded or flanged<br>2 in. and smaller screwed<br>SEE NOTE 1 |
| Chilled water (Optional) | Type L copper | Wrought copper or cast bronze solder end | 2 in. and smaller:<br>No-lead solder |
| Coil Condensate | Schedule 40, galvanized steel or Type M copper | Malleable iron drainage type or wrought copper | Threaded or solder |

NOTES FOR EXHIBIT "A":

NOTE 1: Screwed piping permitted in Crawl Spaces, Mechanical Rooms and Boiler Rooms.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

## 1.02 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

## 1.03 SUBMITTALS

A. Submit shop drawings on all water system specialties.

## 1.04 GENERAL REQUIREMENTS

A. Equipment and accessories shall be rated for a minimum of 125 psi wwp, and 250°F temperatures. Manufacturer's written installation procedures shall become a part of these specifications.

B. Provide equipment, piping, valves, fittings, switches, and miscellaneous equipment necessary and required for the complete installation.

# PART 2 – PRODUCTS

## 2.01 STRAINERS – HVAC WATER SYSTEMS (NON-POTABLE WATER SYSTEMS):

A. Wye Type Strainer:

1. Bronze 2" and Under (Threaded End or Soldered Connections):

   a) Strainer shall be suitable for 400 psi @ 150°F WOG (threaded) and 400 psi @ 100 °F WOG (soldered).

   b) Body: Bronze ASTM B62 or ASTM B584.

   c) Cap: Bronze ASTM B62 or ASTM B584 or Brass ASTM B16.

   d) Screen: Type 304 stainless steel, 20 mesh.

   e) Gasket: Metal filled graphite, PTFE or copper.

   f) Threaded blowdown connection.

   g) Makes: Mueller Model 352M (threaded) or Model 352MS (soldered), Keckley Style F-300 (threaded) or Style E-300 (soldered), Apollo Model 59000 (threaded) or Model 59300 (soldered).

2. Cast Iron 2 ½" and Larger (Flanged End Connection):

   a) Strainer shall be suitable for Class 125, 200 psi @ 150°F WOG (2½" to 12") and 150 psi @ 150 °F WOG (14" and larger) or Class 250, 500 psi @ 150°F WOG (2½" to 12") and 300 psi @ 150 °F WOG (14" and larger).

b) Body and Cover: Cast iron ASTM A126, Class B.

c) Screen: Type 304 stainless steel, 0,062 perforation (2½" to 4") and 0.125 perforations (5" and larger").

d) Gasket: composition.

e) Threaded blowdown connection.

f) Makes: Mueller Model 758 (Class 125) or Model 752 (Class 250), Keckley Style A-7 (Class 125 and 250).

3. Cast Steel 2 ½" and Larger (Flanged End Connection):

a) Strainer shall be suitable for Class 150, 285 psi @ 100°F WOG (2½" to 12") and 150 psi @ 150 °F WOG (14" and larger) or Class 300, 500 psi @ 150°F WOG (2½" to 12") and 300 psi @ 150 °F WOG (14" and larger).

b) Body and Cover: Cast steel ASTM A216, Grade WCB.

c) Screen: Type 304 stainless steel, 0,062 perforation (2½" to 4") and 0.125 perforations (5" and larger").

d) Gasket: Spiral wound Type 304 stainless steel with graphite filler.

e) Threaded blowdown connection.

f) Makes: Mueller Model 781 (Class 150) or Model 782 (Class 300), Keckley Style SA-7 (Class 150 and Class 300).

## 2.02 AUTOMATIC AIR VENTS

A. General Purpose Automatic Air Vent:

1. Float type design to remove contained air or non-condensible gases from liquid piping systems with ¾" threaded connections.

2. Body: Brass.

3. Trim: Stainless steel.

4. Valve and Valve Seat: Stainless steel and EPDM.

5. Design Pressure and Temperature: 150 psi at 240°F.

6. Make: Bell & Gossett Model 87, Taco Model 409 or approved equal.

## 2.03 COIL FLEXIBLE CONNECTORS

A. Bronze Braid and Hose 2" and Under (Soldered End Connection):

1. Hose and Braid Bands: Bronze.

2. End Connections: Copper female soldered ends.

3. Minimum operating pressure of 150 psi at operating temperature of 200°F.

4. Design Equipment: Metraflex Model BBSC.

5. Makes: Metraflex, Mason Industries, Inc., Flex-Hose Co. Inc.

B. Stainless Steel Braid and Hose 2" and Under (Threaded) and 2½ and Larger (Flanged and Grooved Connections):

1. Hose and Braid Bands: Series 300 stainless-steel.

2. End Connections: Carbon steel Class 150 flanged, Sch. 40 carbon steel male threaded or Sch. 40 carbon steel grooved.

3. Minimum operating pressure of 125 psi at operating temperature of 200°F.

4. Design Equipment: Metraflex Model MLPC and RMF (flange to flange), Model GFC (flange to groove), Model GGC (groove to groove), Metraflex Model SSTC (male thread to male thread).

5. Makes: Metraflex, Mason Industries, Inc., Flex-Hose Co. Inc.

## PART 3 - EXECUTION

### 3.01 GENERAL REQUIREMENTS

A. Obtain detailed instructions from each manufacturer for proper method of installation.

B. Equipment and systems shall be installed in accordance with manufacturer's installation requirements.

### 3.02 SYSTEM FILLING

A. Fill each system from low point:

1. With pumps off, vent mains, risers, runouts, and units, working consecutively from low to high point in building. Obtain approximately 2 psi at highest point. Obtain proper air cushion in compression tanks.

### 3.03 AIR VENTING

A. Provide one of the following vents at points in piping system where air may collect.

1. Manual vent assembly consisting of 1-1/4" x 6" air collection chamber, 1/2" ball valve in accessible location, install hose connection on valve outlet.

2. Automatic vent with air chamber. Automatic air vents are only allowed in mechanical spaces.

B. Equipment Vents:

1. When equipment is above mains: Connect runouts or risers to upper quadrant or top of mains. Install vent assembly concealed within enclosure, consisting of 1" diameter by 4" to 6" long air collection chamber with 1/4" soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units such as, radiators, fan convectors and units with return grilles: Provide screwdriver operated manual valve, operated from discharge grille or access door. Drill enclosure and position valve for operating without removing enclosure.

2. When equipment is below mains: Connect piping runouts or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit if required. Use tees instead of ells at low point of runouts.

### 3.04 STRAINERS

A. Provide where called for. Provide blowdown connection for strainers with valves. Provide valve type as specified in Specification Section 230523. All blowdown valves shall be provided with cap or plug. Open ended valves are not allowed.

### 3.05 COIL FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in accordance with manufacturer's installation requirements.

B. Install flexible connectors within manufacturer's parallel offset tolerances. Flexible connectors shall not be subjected to the weight of equipment or piping causing deformation of connector.

## END OF SECTION

# PART 1 – GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

## 1.02 QUALITY ASSURANCE

A. Ductwork shall be fabricated and installed in compliance with latest edition of the following standards:

1. SMACNA Duct Construction Standards - Metal and Flexible Ductwork.

2. SMACNA Duct Liner Application Standard.

3. NFPA Standards, Bulletin 90A, 96, 101.

4. 2020 New York State Mechanical Code

5. Plans and Specifications which exceed the requirements in any of the referenced standards.

B. All sheet metal shall be fabricated and installed by an experienced Contractor specializing in this type of Work.

C. All ductwork shall be maintained to the following cleanliness standards throughout the project:

1. All ductwork is to be shipped to the job site with ends covered in plastic or capped, and fully shrink or poly sheet plastic wrapped. On arrival to the project site, all ductwork shall be manually inspected and anywhere protective plastic or caps that have been damaged shall be cleaned inside and out and re-wrapped prior to storage.

2. Ductwork protective coverings shall be removed only immediately prior to installation.

3. All adhesive labels or part identification markings shall be on the exterior of the ductwork only.

4. All open ends are to be maintained covered through the progress of construction with self-adhesive poly sheeting.

5. Duct contaminated due to failure to maintain these standards shall be cleaned to the satisfaction of the Owner and Engineer at the cost of this contractor.

## 1.03 SUBMITTALS

A. Provide a complete shop standard construction manual including construction details for all shop fabricated materials, fittings, and accessories.

B. Provide coordinated sheetmetal shop drawings. Refer to DUCTWORK SHOP DRAWINGS in this specification section for further requirements.

C. Ductwork detail drawings.

### 1.04 DUCTWORK CLASSIFICATION

A. Duct systems are classified and constructed per the SMACNA pressure classification as follows:

1. All ductwork shall be constructed for a minimum pressure class of 2 in. w.g. unless stated otherwise.

2. Pressure classes above 3 in. w.g. as called for.

### 1.05 DUCTWORK SHOP DRAWINGS

A. Prepare minimum 1/4 in. scale drawings:

1. Constructed from actual field inspections and measurements so as to assure a complete job.

2. Incorporating dimensions of actual equipment proposed for use on the project.

3. Showing adequate sections, elevations, and plan views and indicating the bottom of ductwork elevations from the finished floor.

4. Indicating all volume dampers, damper access doors, air balance test plugs, and other accessories required for a complete project.

B. Immediately call to the attention of the Engineers any major deviations from the Contract Drawings which must be made. All deviations shall be documented in writing.

C. Submit roof, wall and floor opening dimensions and locations shown on shop drawings.

D. Submit prints to each Contractor of other trades for review for interferences and coordination with their work.

E. Refer to 230010.3.2 for further information related to Sheet Metal Shop and Coordination Drawings

## PART 2 – PRODUCTS

### 2.01 DUCTWORK MATERIALS

A. Unless otherwise called for, provide materials in accordance with Exhibit I.

### 2.02 SQUARE AND RECTANGULAR DUCTWORK

A. Transverse and longitudinal duct seams reinforcement shall conform to appropriate tables and figures per SMACNA Pressure Classification for duct construction.

1. “Ductmate" or "Nexus" 4-bolt corner connection systems may be used in lieu of standard construction. Provide all corner brackets, corner bolts, transverse clips, and seals between flange to flange connections

B. Corner closures shall be required as described and illustrated by SMACNA Duct Construction Standards.

C. Throat radius on all elbows shall not be less than dimension of duct in plane of radius. Where this cannot be maintained, use shorter radius with internal guide / splitter vanes per SMACNA guidelines, or square elbow with turning vanes.

D. Bracing and hanging of ductwork shall be per SMACNA Standards for size and pressure class of ductwork being used.

E. Any transformations shall not reduce the ductwork cross-sectional area. Maximum angle in straight duct, 20° for diverging flow and 30° for contraction flow. Transformation from square to round or flat oval seams welded or brazed.

F. Provide 45 degree shoe-taps or 45 degree laterals for square and rectangular branch ductwork. Unless noted otherwise or shown on the contract drawings, 90 degree straight taps or "A" collars are prohibited.

## 2.03 ROUND DUCTWORK

A. Round Ductwork:

1. Manufactured of galvanized steel ASTM A527, gauges per SMACNA Duct Construction Standards, spiral lock-seam or longitudinal fusion-welded, as called for in Exhibit I.

2. All spiral duct shall have locked seams so made as to eliminate leakage under pressure for which this system has been designed. Longitudinal seams duct shall have fusion-welded butt seams.

3. No longitudinal seam duct ("stovepipe") will be allowed.

4. Round ductwork fittings:

a) All fittings fabricated Per SMACNA Standards for round and flat-oval ductwork.

b) Fittings shall have continuous, welded seams.

c) 90° tees shall be conical type. 90° tees and 45° laterals up to and including 12 in. diameter tap size shall have a radiused entrance into the tap, produced by machine or press forming. The entrance shall be free of any restrictions.

d) Round taps off the bottom of rectangular ducts down to diffusers shall be made with a 45° square to round shoe-tap.

e) Spin-in, dovetail, and adjustable take-offs are prohibited unless noted otherwise.

5. Elbows:

a) Diameters 3" through 12": Two-section stamped and continuously welded elbows.

b) Over 12": Gored construction with seams continuous welded. Less than 35° - two gores, 36° to 71° - three gores, over 71° - five gores.

c) Fabricated to a centerline radius of 1.5 times the cross-section diameter.

d) Use of adjustable Elbows is prohibited.

6. Joints:

a) Pipe-to-pipe joints in diameters up to 60" shall be by the use of sleeve couplings, reinforced by rolled beads.

b) Insertion length of sleeve coupling and fitting collar shall be 2" up to 36" diameter and 4" above 36" diameter.

c) Provide intermediate reinforcing angle rings per SMACNA requirements for pressure class indicated.

d) Round metallic ducts shall be fastened by a minimum of three sheet metal screws or rivets spaced equally around the joint. Provide sufficient fasteners that duct sections are securely fastened. This requirement does not apply to round duct used for dryer vent.

## 2.04 DUCTWORK SEALING

A. Ductwork sealing shall comply with paragraphs 403.11 of the ECCCNYS.

B. SMACNA duct sealing classification shall be used for duct systems using the following criteria:

1. Seal Class A, shall include transverse and longitudinal joints and duct wall penetrations, grommets at damper shafts for all ductwork to be provided.

C. Approved ductwork sealing materials shall include the following Hardcast products or approved equivalents when and where applied per manufacturer's recommendations and requirements:

1. Water Based Sealants - Versa-grip 181

D. Mastics used to seal metallic and flexible air connectors shall comply with UL 181B and be marked 181 B-FX for pressure sensitive tape or 181-B-M for mastic.

## 2.05 TURNING VANES

A. Standard Type:

1. Provided in square elbows as shown on contract drawings. Vanes for ducts with areas greater than 100 sq. in. shall be "double" type having dimensions and spacing as detailed.

2. Make: Elgen, or contractor fabricated.

## 2.06 DAMPERS IN DUCTWORK

A. Volume Dampers:

1. Provide single blade type volume dampers where duct sizes in both dimensions are under 12". Constructed per SMACNA standards, one gauge heavier than duct material. For round ducts, Rossi RD series blades securely fastened to 3/8 in. sq., cold rolled steel operator rod and B300/B330 end bushings. For rectangular ducts use Greenheck MBD-10M with 3/8 in. sq., cold rolled steel operator rod. Provide quadrant locking handle on standoff for ductwork to be externally insulated. Wing nut friction screw type are specifically prohibited. Shop fabricated or alternate damper manufacturers meeting these specifications are to be submitted for approval.

2. Provide volume dampers at all air outlets, diffusers, grilles. Dampers to be located at branch takeoff collar or as close as practical. Use of register dampers in return or exhaust inlets shall be strictly limited and approved by the Engineer in advance.

3. Provide multi-blade dampers above 12 in. duct dimension in width or depth. Where multi-blade dampers are required, they shall be equal to Ruskin Model CD35. Provide quadrant locking handle on air volume dampers, wing nut friction screw type are specifically prohibited. Provide quadrant locking handle on standoff for ductwork to be externally insulated.

B. Fire Dampers:

1. See "Fire Dampers" Section 233316.

C. Automatic Air Dampers:

1. Furnished as part of "Control Systems" Section 230923 installed by this Contractor.

D. Self Operating (Backdraft):

1. Construction: 26 gauge extruded aluminum construction. Blades with felted edges. Substantial steel frameworks. Adjustable counterbalance weights which enable the damper to operate in the range of 0.01" to 0.05" w.g. pressure drop at rated cfm, guaranteed not to rattle.

2. Make: Ruskin CBD4 or approved equal

## 2.07 FLEXIBLE DUCTWORK

A. Shall be constructed in compliance with NFPA Bulletin 90A, and UL Standard 181, Class I Air Duct:

1. Consisting of corrosion resistant galvanized steel helix mechanically locked to polyethylene fabric without adhesives.

2. Factory applied, fiberglass exterior insulation, sheathed in fire retardant polyethylene exterior vapor barrier jacket. Refer to Specification 230700 Insulation for required R-Value and insulation thickness.

3. Flexible ductwork shall be rated for 10" w.g. positive pressure, 5" w.g. negative pressure thru 16" dia.; 1" w.g. negative pressure, 18-20" dia.; 5500 fpm, operating temperature range -20$^{o}$F to 250$^{o}$F.

B. Design Equipment: Flexmaster Type 1B (insulated), Flexmaster Type 1NI-C (uninsulated – use limited to where duct insulation is not required by energy code and specifically called for).

C. Make: Clevaflex, Flexmaster, Genflex, Thermaflex.

## 2.08 FLEXIBLE CONNECTIONS TO FANS AND EQUIPMENT

A. Materials for flexible connections shall be fire retardant, water and mildew resistant, and comply with UL Standard 214:

1. Systems up to 2" w.g. s.p.: approximately 20 oz. of fabric per sq. yd. Ventfabrics, Inc., "Ventfab".

2. Systems greater than 2" w.g. s.p., and watertight systems: Of heavy glass fabric, double neoprene coated, approximately 30 oz. per sq. yd. Ventfabrics Inc., "Ventglas".

3. Flexible connections for grease duct system fans shall be listed and labeled for the application per NYSMC 506.3.2.4

## 2.09 ACCESS DOORS

A. In Ductwork: Shall be double panel construction, 1" rigid insulation when in insulated ducts; SMACNA construction, hinged type. Double cam type only acceptable where hinged type will not fit and if approved by engineer. Same metal as duct, or factory fabricated. Doors airtight to fit system static pressure, minimum size 16" x 12" or as practical based on the specified location. Refer to section 233316, "Fire and Smoke Dampers", for additional requirements.

B. When installed in intake or exhaust plenums, access doors will be sized to allow for full access to plenum.

C. Where plenums are greater than 4 feet wide or deep, the access door is to be at least 2 ft. wide by 4 ft. tall to allow for personnel entry.

D. Door Hardware:

1. Hinges: Minimum of two per door, at least 1-1/2" long by 1/8" thick, spaced no more than 2 ft. apart and no more than 1/4 of the door size from top to bottom of door. Maximum 4" length, 6 ft. door, for larger doors, length equal to 1/12 door height.

2. Latches: As manufactured by Ventfabrics, Inc. or equivalent. Metal window sash latch not acceptable.

a) Access doors up to 2" w.g.: Ventlok #100/#102.

b) Walk-in doors up to 2" w.g.: Ventlok #260.

c) Access or walk-in above 2" w.g.: Ventlok #310.

E. Make: Air Balance, Ruskin, Ventlok, Elgen.

## 2.010 ACOUSTIC-THERMAL DUCT LINING IN DUCTWORK

A. Duct Liner (Fiberglass):

1. General: Comply with NFPA Standard 90 and NAIMA Standard AHC-101.

2. Materials: ASTM C 1071, Type I. Acrylic coated glass fiber insulation coated with an anti-microbial EPA registered coating that seals the airstream surface fibers into a smooth, low-friction surface acoustic ductliner shall be of thickness shown in the table. Maximum "K" value to be 0.16 btu/in./sq. ft./degrees F./hr. when tested in accordance to ASTM C518. Absolute roughness per foot not to exceed 0.004 ft. Acoustic duct liner to be suitable for use up to 6000 feet per minute air velocity and temperatures up to 250 degrees F. The acoustic duct liner shall not contribute to the corrosion of steel, copper or aluminum. The liner shall not absorb greater than 0.5% moisture by volume when exposed to air of 120 degrees F., 96% RH. Acoustic duct liner shall provide the minimum sound absorption coefficients shown below when tested per ASTM C423-90 and ASTM E795, Mounting Type A.

| **OCTAVE BAND FREQUENCIES HZ** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Thickness | 125 | 250 | 500 | 1000 | 2000 | 4000 | NRC |
| 1-1/2 in. | .16 | .51 | .90 | 1.05 | 1.06 | 1.01 | .90 |
| 2 in. | .23 | .73 | 1.05 | 1.13 | 1.06 | 1.07 | 1.00 |

3. Thickness: Refer to section 230700 for ductwork insulation requirements. Where insulation is provided solely for acoustic purposes, minimum insulation thickness shall be 1 ½ inches.

4. Fire Hazard Classification: Flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 and UL 723.

5. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C919.

6. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50 pound tensile dead load test perpendicular to the duct wall.

7. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.

8. Adhesive for attachment of mechanical fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

### 2.011 INSTRUMENT TEST HOLES

A. Suitable for insertion pitot tubes and other test instruments:

B. Fabricated with heavy screw cap and gasket.

C. With sufficient extension to accommodate exterior insulation where required.

D. Make: Ventlok #699.

## PART 3 – EXECUTION

### 3.01 REQUIREMENTS

A. Equipment and systems shall be installed in accordance with local and state codes and regulations having jurisdiction.

B. Install all ductwork concealed and tight to the structure above unless noted otherwise on shop drawings. Fabricate only after the approval of shop drawings, and in locations to avoid interference. Ductwork installed without approved shop drawings, which requires removal/modification and/or reinstallation due to conflicts or improper installation shall be corrected at no cost to the Owner.

C. Sizes given on contract drawings are inside dimensions. Keep openings closed with protective caps or blanks during construction to prevent entrance of dirt and debris.

D. Extend access openings, damper rods and levers, to outside of external insulation make systems airtight.

E. No piping, conduit or other obstruction to airflow is permitted in ductwork.

F. Provide necessary openings, sleeves, hanger inserts, framing, chases, and recesses, not provided by other trades.

G. Exposed exhaust or return registers and grilles shall be flush with face of duct; exposed supply registers and grilles shall be mounted outside airstream with 45$^{o}$ shoe-tap extension collars.

### 3.02 FLEXIBLE CONNECTIONS

A. Provide flexible connections for the intake and discharge connections of duct connected to fans and air handling equipment:

1. Round connections made with adhesive and metal drawbands with ends tightly bolted.

2. Rectangular connections made with material securely held in grooved seam between flanges, tightly clipped or riveted on 6” centers.

B. Connections made with a minimum of 2" space between duct and equipment collars, installed in line, and with 1" excess material folded so as not to interfere with airflow through connection.

## 3.03 FLEXIBLE DUCTWORK

A. Install flexible duct systems, including connections and joints, in accordance with manufacturer's installation instructions, ADC Flexible Duct Performance and Installation Standards Chapter 4 "Installation Requirements", and with UL 181, Class 1 Air Duct.

B. Flexible ductwork shall not pass through any wall, floor or ceiling.

C. Duct slide on depth minimum of 2" and secured with ½" stainless steel worm gear clamp or non-metallic band clamp meeting UL 181B-C. Connections to conform with all manufacturer's requirements. Maintain insulation value and vapor barrier without gaps from branch main to diffuser / grille / register connection.

D. For round-to-oval connections, provide round-oval flexible adapter.

E. Maximum length 48", not to penetrate any wall, ceiling or floor.

F. Maximum one 90° angle wide radius bend from ductwork to outlet. Provide molded flexible elbow support secured to structure to support bend radius. Thermaflex flexflow or approved equal. Use of Panduit straps unapproved means of bend support are specifically prohibited. Where a wide radius cannot be maintained, provide hard duct elbow at outlet.

## 3.04 TURNING VANES

A. Install fixed turning vanes in square elbows of equal dimensions only.

1. Provide turning vanes in compliance with SMACNA duct construction standards figures 2.3 and 2.4

2. Use large size vanes, 2-1/4" spacing when ducts are 20" or wider.

3. Secure vane runners to duct with spot welding, riveting or sheet metal screws.

4. Seal all penetrations for attachment of vane runners.

B. For unequal dimension elbows:

1. Provide Aero Dyne HEP turning vanes and rail assembly or approved equal

2. Turning valves to be installed in compliance with all manufacturer requirements to obtain intended performance.

3. Adjust vanes for angle of attack per manufacturer instructions

4. Seal all penetrations for attachment of vane runners.

C. When installing in ductwork with internal insulation:

1. Install runners in ductwork inside insulation and bolt through insulation and duct sides, welding bolts to insure rigid installation. Provide build-outs for duct Velocity-Pressure classes above 2" w.g.

### 3.05 INSTRUMENT TEST HOLES

A. Locate in the following locations:

1. Downstream of fan discharge

2. Downstream of fan inlet.

### 3.06 CLEANING DUCTWORK AFTER INSTALLATION

A. Clean rubbish and dirt from system before fans are turned on.

B. Keep openings closed during this construction period.

C. Pay damages resulting from dirt blown on painted or other finished surfaces.

D. Repair or replace damaged fan wheels, dampers, or other system parts damaged as a result of dirt.

E. Clean system as many times as required until the entire system is dirt-free.

### 3.07 INSTALLATION ROUND DUCTWORK

A. Use factory fabricated couplings for joints.

B. After the joint is slipped together, sheet metal screws are placed ½" from the joint bead for mechanical strength.

C. Sealer is applied to the outside of the joint and covering the screw heads.

D. Flanged joints shall be made with neoprene rubber gaskets.

### 3.08 LEAKAGE TEST OF DUCTWORK

A. Ductwork designated to operate below 3" wc shall be checked and guaranteed to meet standards of SMACNA Seal and Leakage Classifications, seal Class A. Air balancing and testing shall be used to determine satisfactory operation of duct systems.

### 3.09 DAMPERS AND AIR CONTROL DEVICES

A. Provide dampers necessary to permit proper balancing of air quantities. Comply with code requirements for smoke and fire control. Prevent introduction of uncontrolled outside air into building through roof and wall openings.

B. When dampers are installed in acoustically lined ductwork, install with insulated "build-outs" per SMACNA.

C. Install fire dampers in accordance with "Fire Dampers" Section and applicable codes.

D. Install all dampers furnished as part of "Control Systems" Section.

### 3.010 ACCESS DOORS

A. Provide as required for maintenance and service access at:

1. Control dampers

2. Damper motors

3. Fire dampers for inspection and services as required under NFPA 80 and NFPA 105.

4. Smoke detectors

5. Control instruments

6. Fan bearings

7. Intake or exhaust plenums

8. Any other equipment requiring periodic inspection or service, complete with angle iron frame.

**3.011 DUCT SUPPORTS**

A. Provide per SMACNA, same material as duct. Hanger bands to extend down sides and turn under bottom 2". Minimum two metal screws per hanger. Steel angle or "unistrut" on larger duct. Spaced per building structural system but not greater than 8 ft or the maximum allowable by SMACNA guidelines. Provide extra support angles as required.

B. Provide supports per manufacturers requirements for factory fabricated duct systems

C. Refer to section 230550 for wind restraint of exterior ductwork systems.

**3.012 ACOUSTIC-THERMAL DUCT LINING**

A. Duct area on project drawings are clear areas. Increase metal duct dimensions to accommodate lining.

B. Adhere lining to interior side of duct; minimum 90% coverage of Benjamin Foster 85-20 fire retardant adhesive, UL approved. Stapling method of attaching will not be permitted. Mechanical fasteners shall not pierce the sheet metal. Installing fasteners with spacing as per SMACNA Standards. Multiple layers of liner to achieve indicated thickness is prohibited.

C. Butting edges of acoustic linings shall be sealed with a fire-resistant neoprene coating, and exposed edges of acoustic linings shall be installed with sheet metal nosing to prevent erosion.

D. Lining shall not impart odor to the air, delaminate or be loosened by the airstream under normal operating conditions. Lining which is damaged during fabrication or shipment shall not be installed.

E. Linings shall be interrupted at the area of operation of a fire damper and at not less than 6 inches upstream and downstream of electric-resistance and fuel burning heaters in duct systems.

F. Metal nosings or sleeves shall be installed over exposed duct liner edges that face the opposite direction of the air flow.

G. Where a duct liner has been interrupted, a duct covering of equal thermal performance shall be installed.

H. Thermal acoustic duct liner shall not be used to line ducts or plenums from the exit of a cooling coil to the downstream end of the drain pan.

**3.013 SMOKE DETECTION**

A. Smoke detectors shall be furnished by Division 26 "Electrical". This Contractor shall install detectors located in ductwork. Clearly indicate locations of smoke detectors on the sheet metal shop drawings.

B. Increase duct size at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size required with Division 26 "Electrical".

EXHIBIT I - DUCTWORK MATERIALS
(Notes are at the end of Exhibit "I")

| SERVICE | MATERIAL | SPECIAL REQUIREMENTS |
|---|---|---|
| Supply, return, vent, relief, and exhaust | Lock forming quality, galvanized steel ASTM 525 | Joints and features as called for SEE NOTE 1 |
| Accessories, dampers and air turns | Same or better as parent duct | ------ |
| Field constructed apparatus casings | Galvanized steel ASTM 525 | |

NOTES FOR EXHIBIT I:

NOTE 1: Exhaust ductwork downstream of roof mounted exhaust fans shall be acoustically lined for a minimum of 8 ft.

## END OF SECTION

# PART 1 – GENERAL

## 1.01 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation as shown on the Contract Documents.

## 1.02 SUBMITTALS

A. Types, schedule of sizes, locations, and installation arrangements of all dampers.

B. Manufacturers UL listed installation details for each mounting arrangement.

C. Installation certification per paragraph 3.3 of this section.

D. Identification chart for dampers per paragraph 3.4 of this section.

E. Size, location and construction detail of all fire rated access doors.

## 1.03 QUALIFICATIONS

A. Provide work in accordance with latest requirements of the New York State Building Code, NFPA 90A, NFPA 101 and UL 555 (Seventh Edition), UL 555S (Fifth Edition). Fire dampers shall be Underwriter's Laboratories classified.

B. All Dampers shall be rated for protection at 350°F and shall be Leakage Class I.

C. All fire rated access doors shall be in accordance with NFPA 80 and 104.

# PART 2 – PRODUCTS

## 2.01 FIRE DAMPERS

A. Rectangular - Curtain type damper of galvanized steel construction with fusible link, roll formed frame and stainless steel closure spring. UL listed and labeled.

B. Round – 20 gauge galvanized steel sleeve / frame, with 14 gauge galvanized blades. Stainless steel bearings pressed into frame. UL listed and labeled.

C. Dampers are to be selected for no more than 0.1”wc pressure drop in the as-installed conditions, but in no case shall be smaller than the ductwork size stated on the project drawings. Provide necessary duct transitions, sleeves and supports to maintain assembly rating and these free area requirements.

D. Provide duct transitions where duct sizes must be increased to maintain maximum allowable pressure drop or for transition between round / oval / rectangular ductwork systems.

E. 1-1/2 hour rated dampers for assemblies with rating under three hours. Three-hour rated dampers for assemblies with rating of 3 hours or greater.

F. Provide with “break away” duct connections which comply with rated assembly construction details.

G. Fusible link temperature rating of 165°F.

H. Type A as called for on the contract drawings or as required to meet installed pressure drop and performance requirements.

I. Stainless steel or all aluminum construction where required based on application.

J. Design Equipment:

1. Rectangular:

a) Static, 1 ½ hour, Ruskin Model IBD2

b) Static, 3 hour, Ruskin Model IBD23

2. Round – Ruskin FDR25, Static up to 2000fpm.

K. Make: Ruskin, Air Balance, Greenheck, National Controlled Air, Prefco, Safe Air, Inc., Venco.

### 2.02 FIRE RATED ACCESS DOORS

A. Fire rated access doors shall be designed specifically for application rated wall openings and shall bear an Underwriters' Laboratories fire door label for a two or three-hour rating to match adjacent construction.

B. Design Equipment:

1. Two hour rated for walls – Activar FD Series

2. Three hour rated for walls – Activar FD3 Series

C. Make: Air Balance, Duro, Prefco, Cesco.

## PART 3 – EXECUTION

### 3.01 LOCATIONS

A. Provide where called for on the contract drawings and as required per Section 607 of the New York State Mechanical Code.

### 3.02 INSTALLATION

A. Provide sleeves, angles, and access doors for installation in accordance requirements of NFPA, UL and damper manufacturer. Provide sheet metal access doors in ductwork for dampers and accessories. Provide ceiling or wall access doors for dampers and accessories. Provide rated access doors where required in shafts and other rated assemblies.

B. All fire dampers to be selected and fully coordinated with access requirements, including required service access and inspection doors. Final selection details, including upstream vs downstream positioning of access doors and damper actuators shall be determined during development of project coordination drawings as described under 230010.3.2.

C. Provide access door or removable ductwork section for inspection and repair in compliance with NFPA 80 and NFPA 104 for all assemblies. Minimum allowable access door size shall be 12”x12”, minimum allowable length for removable duct section shall be 24 inches.

### 3.03 CERTIFICATION

A. Contractor shall certify that dampers are accessible for servicing, are installed properly, and are operational. Submit three copies of signed certification to the Owner's Representative for review.

### 3.04 IDENTIFICATION

A. Provide damper tags and chart. Fasten tag to ductwork adjacent to the dampers. Number each damper and make chart listing.

1. Number

2. Location

3. Air system in which they are installed.

B. Submit three copies of chart to the Owner's Representative for review.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Drawings.

## 1.02 SUBMITTALS

A. Submittals shall include all fans, motors, drives, and accessories. Include all fan curves and fan operating point.

## 1.03 QUALITY ASSURANCE

A. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories shall be provided as called for or scheduled. All ratings shall be made in accordance with AMCA Standard 210. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed. The manufacturer shall guarantee sound-power level ratings not exceeding those of the design equipment. All equipment shall be statically and dynamically balanced to acceptable tolerances with weights permanently fastened. Fan wheels shall be rebalanced in the field, if necessary.

B. Fans shall be selected such that the rotational speed does not exceed 80% of that allowable for the fan class to be provided.

C. Motors:

1. Motors shall be furnished with each fan of sizes scheduled. Refer to specification Section 230513 for acceptable motor manufacturers. All belt-driven fan motors shall be mounted on either an adjustable slide base or a pivoting base.

2. Fans specified either through model number or motor type to contain ECM motors shall be provided with either local speed adjustment modules or controllers allowing interface to the BMS as required for specified sequences of operation.

D. Drive Systems:

1. Provide fans with direct drive systems as scheduled.

# PART 2 - PRODUCTS

## 2.01 ROOF FANS (DOME TYPE)

A. Centrifugal type fan wheel with backward curved blades. Spun aluminum housing. Fan enclosure with removable dome for access to motor, drive, bearings and fan wheel. The motor shall be mounted on an adjustable base. Permanently lubricated sealed motor bearings.

B. Fan Bearings: 80,000 L-10 life hours per AFBMA.

C. 1/2" x 1/2" aluminum mesh bird screen. Factory mounted and wired disconnect switch. Factory mounted and wired variable speed controller for all direct drive fans. Factory constructed roof curb in accordance with Section 230509.

D. Design Equipment: Greenheck Vari-Green.

E. Acceptable Make: Greenheck, Carnes, Cook, Penn.

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF EQUIPMENT

A. Provide equipment in accordance with manufacturer's instructions. All fans shall meet the intent of the system performance requirements. Provide rubber in-shear vibration isolation for all fans unless otherwise called for differently. Provide necessary supporting ironwork and platforms for equipment as detailed on the contract drawings. Provide guards for all exposed belts, shafts and fan wheels. Change pulley sizes or adjust sheaves as required to make systems deliver specified quantities of air as listed on the Contract Drawings.

B. Provide fan control equipment as specified or scheduled on the Contract Drawings. Coordinate location of fan control equipment with all contractors.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

## 1.02 SUBMITTALS

A. Registers/Grilles/Diffusers. Submit room schedule listing size, throw, direction of throw, accessories, finish, noise criteria levels, material type and color chart.

## 1.03 GENERAL REQUIREMENTS

A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Owner's Representative of problems prior to shop drawing submittal.

B. Pressure drop, air flow and noise criteria selection are based on design equipment. Manufacturers not submitting design equipment must provide written certification in the front of submittal that equipment submitted has been checked against and performs equal to the design equipment.

## 1.04 REQUIREMENTS FOR REGISTERS

A. General:

1. A register is defined as a grille plus a volume damper.

2. Registers shall be installed "sight-proof" where possible, i.e., high wall register with horizontal blades inclined up, or along a wall with blades facing the wall.

3. Borders and frames shall be of same material as register face unless specified otherwise.

B. Mounting Frames:

1. Provide with screw holes in register face punched and countersunk at factory, and mounting frame drilled and tapped to suit. Sponge rubber gasket between frame and wall or ceiling for all surface mounted frames.

2. Frame shall be overlap type and shall be suitable for type of ceiling where register is to be installed.

C. Finishes:

1. Baked enamel (of colors as selected from the manufacturer's standard color chart) natural anodized**,** as scheduled.

D. Design Equipment: Price unless otherwise noted.

E. Make: Price, Carnes, Krueger, Titus, Tuttle and Bailey

## PART 2 - PRODUCTS

### 2.01 REGISTER TYPES

A. Type A - (exhaust grilles):

1. Steel construction with 18 gauge frame and blades, with horizontal bars on a 3/4" spacing set at 45° fixed deflection.

2. 1-1/4” wide flange.

3. The blades shall be parallel to the long dimension.

4. Model: Price 530.

B. Type B - (Relief grille):

1. Aluminum construction with 3/32” blades, with horizontal bars on a 1/2" spacing set at 0° fixed deflection.

2. 1-1/4” wide flange.

3. The blades shall be parallel to long dimension.

4. Model: Price LBP, core 15B.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions. Rough-in or install per reflected ceiling plan or in locations instructed by Owner's Representative.

B. When the final connection to an exhaust or return grille is made, a 12” minimum height plenum box must be supplied to all grilles. Plenum dimensions shall match grille size.

C. Where a plenum is provided for a register, grille, or diffusers, the plenum interior shall be painted flat black.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

## 1.02 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all the requirements therein.

## 1.03 SUBMITTALS TO THE ARCHITECT/ENGINEER

A. Louvers including all blade types, finishes and arrangements.

B. Provide original color charts for selection of finish.

C. Insulated panels including materials and finishes.

# PART 2 - PRODUCTS

## 2.01 LOUVERS

A. Factory constructed aluminum louvers.

B. Provide mullions where blade lengths exceed 60 in.

C. With 1/2 " x 1/2" mesh, 14 gauge wire, aluminum birdscreen secured in removable frame, secured to back of louver.

D. Extruded sections 6063-T5 alloy, 0.125” minimum thickness, 4” deep, Double Drainable unless otherwise called for.

E. Sill extension and sill style as required by job conditions.

F. Standard anodized (Clear) 70 % finish color as selected at review of submittal.

G. Size, type and free areas indicated in location as called for on the Contract Documents.

H. "Stormproof" design with special curb to trap rain.

I. One-piece structural head, sill, and jambs to eliminate requirement for on-site assembly.

J. All stainless steel fasteners.

K. Design Equipment: Greenheck ESD-435 (4”) Double Drainable Blade.

L. Acceptable Make: Construction Specialties, Inc., Greenheck, Ruskin, Pottorff.

### 2.02 INSULATED BLANK OFF PANELS

A. General: Fabricate blank-off panels from materials and to sizes indicated and comply with the following requirements:

1. Finish: Same as finish applied to louvers.

2. Attach blank-off panels to back of louver frames with stainless-steel sheet-metal screws.

B. Insulated, Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets, complying with the following requirements:

1. Thickness: 2 inches (50 mm).

2. Metal Facing Sheets: Aluminum sheet, 0.032 inch (0.8mm) thick.

3. Insulating Core: Extruded-polystyrene insulation board complying with ASTM C 578, Type VII.

4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum channel frames 0.081 inch (2.06mm) thick, with corners mitered and with same finish as panels.

5. Seal perimeter joints between panel faces and louver frames with 1/8-by-1-inch (3.2-by-25mm) PVC compression gaskets.

## PART 3 - EXECUTION

### 3.01 GENERAL

A. Install louvers per manufacturer's recommendations.

### 3.02 LOUVERS

A. Size called for is approximate wall/or masonry opening size. Adjust slightly to suit construction or coursing (review architectural drawings or field conditions for rough opening sizes). Slope ductwork and plenum to louver weephole or provide drain.

B. Install blank off panels where indicated on contract drawings.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

## 1.02 SUBMITTALS

A. Submit shop drawings on gravity heating equipment with color selection chart. Clearly indicate which equipment is being submitted.

# PART 2 - PRODUCTS

## 2.01 GENERAL REQUIREMENTS

A. All equipment shall be free from expansion, noises and strains. Exposed parts to be cleaned and parkerized or phosphate coated before prime coating or baked enameling. Finish colors as selected from manufacturers standard colors during the submittal process. Factory-boxed and tagged by room numbers. Access doors shall be provided in cabinet at locations of valves, flow balancers and air vents. Verify at site, the space available for each piece of equipment. Top of heating unit enclosures shall be at least 1 in. below top of windowsill. Bottom of heating unit enclosures, unless otherwise called for, approximately 6 in. above floor and above the base molding. Refer to Owner's representative at once, any correction, discrepancy or suggested change in size or location. This Contractor responsible for proper location and size of recesses. Coordinate dimensions from floor to bottom of recess with other trades. Provide framing in recess and shims, if required.

B. All capacities shall be IBR approved ratings. Units shall be IBR approved as a complete assembly including element and cover.

## 2.02 FIN RADIATION

A. General Requirements:

1. Complete enclosure, continuous supporting channel backplate, heating element, hangers and accessories, as specified and shown on the Contract Drawings.

2. Enclosures to run from wall-to-wall unless otherwise called. Provide necessary corner pieces, end caps, column enclosures, butt trims, wall sleeves, with access doors. Do not leave any enclosure installed without an end trim piece.

B. Heating Element:

1. Hot Water System: Seamless copper tube with non ferrous fins, 125 lbs. minimum hydrostatic test pressure. .020" tube wall thickness, minimum. .020" fin thickness, minimum.

2. Tube mechanically expanded to fin collars for permanent metal to metal contact.

3. Properly support with pitch adjustment. Silent element and pipe support. Locate a maximum of 2'-0" apart. Support shall allow for lateral movement for expansion and contraction of heating equipment.

C. Enclosures:

1. Enclosure fronts 16 gauge furniture steel.

a) Flat top with stamped grille. Extruded aluminum anodized grille as scheduled on drawings.

b) Edges and corners rounded. Individual sections not over 6 ft. No exposed areas shall have sharp edges.

c) Mechanically fastened to wall bracket.

d) Continuous interlocking slip joint fit between adjoining covers. Finish shall match enclosure fronts along entire male and female sides.

e) Enclosure accessories shall fit tight to wall at sides, in back plate at top and extend back and mechanically screw to wall at bottom.

2. Support channel partial backplate with top wall gasket and supports:

a) 18 gauge securely fasten to wall.

b) Enclosure front braced by internal channel braces. Minimum on either side of joint seam.

c) No sheet metal screws or other fastening devices shall be visible.

d) Provide wall brackets or stiffening supports adjacent to each joint and at least every 16 in., maximum 24" O.C.

3. Top of cover rest on backplate only and not between wall and backplate.

4. Accessories:

a) Pedestal brackets or bottom panel when required for style.

D. Design Equipment: Rittling IBG5 & IBG3

E. Make: Rittling, Sterling, Trane.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Each unit isolated with shut-off ball valves to permit servicing. Provide flow balancer for each unit as detailed. Provide trap for each unit as detailed. Contractor responsible for correct end connections and arrangements. Arrange piping accessories and valving fully accessible for servicing. Enclosures fastened to structure with screws or bolts, no nailing allowed. Fasten at 6 in. O.C. Provide air collecting chamber and manual vent on return end of each heating unit on all upfeed hot water installations.

B. Install enclosure only to conceal piping between unit ventilators where indicated on contract drawings. Refer to schedule on drawing KH H 600 for dimensions and drawings KH H 402 & KH H 403 for locations.

## END OF SECTION

# PART 1 - GENERAL

## 1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

## 1.02 SUBMITTALS

A. Unit ventilators.

B. Contractor shall provide one (1) mockup of unit ventilator assembly, complete with pipe cover assembly, wall sleeve, louver and components for approval by mechanical engineer, architect, and owner.

## 1.03 ARRANGE FOR UNIT VENTILATOR MANUFACTURER TO

A. Provide Detailed Drawings of Unit Ventilator for Each Typical Room.

B. Thoroughly instruct Heating Contractor in installation of intake boxes, unit ventilator cabinets, metal shelving, etc. Upon completion, examine complete installation and certify in writing that installation is in accordance with manufacturers instructions.

C. Complete testing and start-up for each unit shall be performed by the manufacturers authorized representative.

D. Instruct Owner Representative in operation and care of unit ventilator system.

# PART 2 - PRODUCTS

## 2.01 GENERAL

A. Equipment of one manufacturer. Each system shall include complete field installed temperature control system. Surfaces baked enamel finish, color as selected from manufacturers standard colors. Equipment boxed separately and tagged by room number.

B. Design Equipment: Trane

C. Make: Trane, Daikin, Carrier.

## 2.02 UNIT VENTILATORS

A. Cabinets:

1. Casing constructed of 16 gauge furniture steel.

2. Removable portion for access to motor, fan assembly, filters and damper.

3. Right and left removable covers shall not effect unit operation for servicing and testing.

4. Enclosure constructed in such manner that all internal operating parts accessible for service or replacement.

5. Removable discharge grille to direct flow with adjustable outlet. 1/4" mesh debris screen beneath the discharge grille.

6. Positive method of preventing "blow-through."

7. All vertical units shall be 30" high, 21-7/8" depth with full adapter back. **Wall sleeve length to be field verified by unit manufacturer.**

8. Capacity based on standard air, as called for on plans; certified in accordance with ASHRAE.

9. Gasket around perimeter of outside air intake arranged in location as required to butt general construction and prevent infiltration.

10. Gasket around back perimeter of unit.

11. Separate outside air and return air dampers. Damper shall be fully proportioning and capable of providing up to 100% outside air.

B. Heating Coils:

1. Copper tubes and headers, nonferrous fins.

2. Hot water: Sinuous type, multi-pass.

3. Face and bypass dampers.

C. Chilled Water Coil

1. Insulated drip pan with corrosion resistant mastic coating with drain connections on both sides.

2. Proof and leak tested before leaving the manufacturer. The proof test isperformed at 1.5 times the maximum operating pressure, and leak tested at the maximum operating pressure.

3. Coils shall be selected and rated in accordance with ARI 440.

4. Seamless copper tubing and aluminum fins. Fins of ripple design without a hooked trailing edge.

D. Motors/Fans:

1. The (supply) ECM motor shall be equipped with a local speed potentiometer capable of dry contact enable/disable control by BMS.

2. Built-in overload protection.

3. Resilient mountings to dissipate noise and magnetic vibration.

E. Filters:

1. One inch thick, MERV 8, pleated media throwaway type filters with access through return air grille.

2. Install clean filters in each unit prior to final acceptance.

F. An electrical disconnect switch shall be provided for field connection of power wiring. All power wiring within unit from disconnect switch on is by the unit manufacturer.

G. Intakes and Wall Boxes:

1. The wall sleeve shall be a one piece 14 gauge aluminum piece either integral to or field fastened

and grouted to the cabinet.

2. Outdoor air intakes:

   a) Refer to specification 233726 for louver information.

   b) Securely fasten to intake sleeve and caulk perimeter airtight. Clear anodized finish. No flanges where installed in brick wall. Provide flanges, when installed in metal panel.

3. To fit installation as shown on General Contract Drawings.

4. Pitch to drain outside.

5. Caulk between intake boxes and wall openings to maintain weatherproof installation.

H. Controls:

1. All temperature controls shall be field installed by the temperature control subcontractor.

## PART 3 - EXECUTION

### 3.01 HEATING CONTRACTOR'S RESPONSIBILITY

A. This contractor responsible to:

1. Order correct end connections for supply, return, electric and dampers.

2. Order correct coil hand connections for unit ventilators. Hot Water and chilled water coil connections shall be on opposite sides of the unit.

3. Obtain complete instructions from unit manufacturer regarding each item and proper installation of same.

4. Make certain and guarantee that airtight sealing is made between air opening and unit back.

5. Make installation water and weathertight; guarantee same.

6. Check building construction to see that same will allow proper installation. If not satisfactory, notify Architects.

7. Obtain correct end roughing for electric. Coordinate with Division 26, Electric.

8. Establish exact location of intake boxes.

### 3.02 INSTALLATION

A. Fasten securely to wall and floor with expansion bolts.

1. With tight fitting neoprene gasket around air intake.

2. Provide felt or sponge rubber pad between unit and floor.

3. Shim and align unit ventilators.

4. Arrange valving and piping and accessories accessible for servicing.

5. Provide extra thick compressible insulation on back of unit to insure no leakage of outside air beyond unit intake.

B. This Contractor responsible for proper setting and location of units and intake boxes, grilles and sleeves.

1. Correct, as part of Contract, any misplaced or improperly set units or intake boxes.

C. Protect units from damage until final acceptance:

1. Restore or replace any damaged part.

## END OF SECTION

SECTION 260010 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 26, 27, & 28.

1.2 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the 2020 National Electric Code and with the governing rules and regulations of federal, state and local governmental agencies.

B. The following is a list of codes and standards that will apply to this project:

1. 2021 International Building Code
2. 2021 International Energy Conservation Code
3. 2016 and 2017 Supplement to the New York State Energy Construction Code
4. New York State Department of Labor Rules and Regulations
5. Federal Occupational Safety and Health Act - OSHA.
6. National Electrical Code, NFPA 70
7. Electrical Safety Requirements, NFPA 70E
8. National Fire Alarm Code, NFPA 72
9. Life Safety Codes NFPA 101
10. Local Codes and Ordinances for Erie County, NY
11. NEMA Standards
12. Factory Mutual or other Insurance Carrier.
13. Environmental Protection Agency (EPA) – Title 40 Chapter I, Subchapter N Part 469 - Removed materials shall be disposed of properly in accordance with the United States Environmental Protection Agency (EPA).

1.3 LICENSING & PERMITS

A. Provide certificate of inspection from Commonwealth Electrical Inspection Services Inc. for all electrical work prior to acceptance of each phase.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid. Provide third party inspection of all electrical work by a certified inspection agency or approved professional.

C. Refer to General Conditions of the Contract for additional requirements.

1.4 GLOSSARY

| | |
|---|---|
| ACI | American Concrete Institute |
| ADA | American Disabilities Act |
| AGCA | Associated General Contractors of America, Inc. |
| AIA | American Institute of Architects |
| AISC | American Institute of Steel Construction |
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing Materials |
| AWSC | American Welding Society Code |
| EPA | Environmental Protection Agency |
| FM | Factory Mutual Insurance Company |
| IEEE | Institute of Electrical and Electronics Engineers |
| ISO | International Standards Organization |
| NYBFU | New York Board of Fire Underwriters |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers' Association |
| NESC | National Electrical Safety Code |
| NFPA | National Fire Protection Association |
| NYS/DEC | New York State Department of Environmental Conservation |
| NYS/UFBC | New York State Uniform Fire Prevention and Building Code |
| OSHA | Occupational Safety and Health Administration |
| UFPO | Underground Facilities Protective Organization |
| UL | Underwriter's Laboratories, Inc. |

1.5 DEFINITIONS

| | |
|---|---|
| Abandoned | Materials not removed and not electrically connected. |
| Approved / Approval | Written permission to use a material or system. |
| AHJ | Autnority Having Jurisdiction |
| As Called For | Materials, equipment including the execution specified/shown in the contract documents. |
| Code Requirements | Minimum requirements. |
| Concealed | Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade. |
| Design Equipment | Refer to the article, BASIS OF DESIGN. |
| Design Make | Refer to the article, BASIS OF DESIGN. |
| Equal or Equivalent | Equally acceptable as determined by Owner’s Representative |
| Exposed | Work not identified as concealed. |
| EPA | Environmental Protection Agency |
| Final Acceptance | Owner acceptance of the project from Contractor upon certification by Owner's Representative. |
| Furnish | Supply and deliver to installation location. |

| | |
|---|---|
| Furnished by Others | Receive delivery at job site or where called for and install. |
| Finished | Space equipped with finished surfaces. |
| Inspection | Visual observations by Owner's site Representative. |
| Install | Mount and connect equipment and associated materials ready for use. |
| Labeled | Refers to classification by a standards agency. |
| Make | Refer to the article, BASIS OF DESIGN. |
| Or Approved Equal | Approved equal or equivalent as determined by Owner's Representative. |
| Owner's Representative | The Prime Professional |
| Prime Professional | Architect or Engineer having a contract directly with the Owner for professional services. |
| Provide | Furnish, install and connect ready for use. |
| Relocate | Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use. |
| Replace | Remove and provide new item. |
| Review | A general contractual conformance check of specified products. |
| Rough-in | Pipe, duct, conduit, equipment layout and installation. |
| Satisfactory | As specified in contract documents. |
| Site Representative | Construction Manager or Owner's Inspector at the work site. |
| Unfinished Area | Space without finished surfaces. |

Refer to General Conditions of the Contract for additional definitions.

1.6 BASIS OF DESIGN

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger electrical feeders, circuit breakers, equipment, additional control devices and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of rough-in and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.7 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, fixtures, panelboards, conduits, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, the size and the quantity of branch circuit conductors, and the panelboard or interconnection box from which the branch circuit is served.

1.8 QUALITY ASSURANCE

A. Manufactures of equipment shall be firms regularly engaged in the production of factory fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

1.9 ABSENCE OF SPECIFICATION

A. Where the drawings or the specifications do not name a particular brand or manufacturer of any item, these items are still part of the Work. This Contractor shall provide all such items that may be fairly and reasonably judged throughout the construction industry to be the most appropriate and best quality item for the intended application. Provide submittals for proposed items to the Architect for review and approval.

1.10 DISCREPANCY IN DRAWINGS AND/OR SPECIFICATIONS

A. Where the drawings and/or the specifications pose a conflict in design intent requirements, quality of work, or equipment the contractor must submit an RFI for clarification during the bid process in compliance with the front end specifications to provide resolution or provide the greater of the conflicting equipment or workmanship after the submission of bid, or cutoff date for RFI's.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. The Materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted to the Architect/Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material equipment being substituted, cut sheets, installation drawings, performance and test data and warranties. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders.

C. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are not acceptable.

D. Substitutions shall not alleviate the contractor from coordination of performance issues by the substituted material, product, equipment.

2.2 MATERIALS

A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

B. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems conform to the Specifications.

2.3 U.L. LISTING

A. Equipment shall bear the Underwriter's Laboratories (UL), or other approved agency listing label. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with the National Electric Code and listed by U.L.

2.4 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings Shall Be Dated and Contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Incomplete submittals will not be accepted. All products specified in an individual Division 26, 27, and 28 specification sections shall be submitted at the same time and each separate section shall have its own submittal. Number each submittal and do not combine multiple specification sections into a single submittal. Indicate deviations from contract requirements on Letter of Transmittal. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

PART 3 - EXECUTION

3.1 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings in the form of reproducible transparencies drawn at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:

1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be sepias of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted

items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

2. HVAC Contract will provide sepia transparencies and/or prints and submit the base plan to all major trades' Contractors.

3. Electrical, Plumbing and Fire Protection Contracts will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

3.2 ELECTRONIC CAD DRAWING FILES

A. A Digital Data Licensing Agreement, AIA Document C106-2013, shall be filled out and signed by both parties prior to transmitting any digital data.

B. The Engineer may provide the Contractor with CAD files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors' responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors' coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

C. Any additional cost for changes due to conflicts as a result of the Contractors' failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

D. If the Contractor requests electronic CAD files from the Engineer and this request is granted, the Contractor shall pay the Engineer's $100 per drawing to process this request.

3.3 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough-in work do not scale documents. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owners representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location of all equipment in

finished areas, such as thermostat, fixture and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

2. Before rough-in for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved rough-in drawings giving exact location for each piece of equipment. Do not "rough-in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any “rough-ins” that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the electrical contractor at no expense to the Owner.

3. For equipment and connections provided in this contract, prepare rough-in drawings as follows:

   a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.

   b. New equipment: Obtain equipment rough-in drawings and dimensions, then prepare rough-in drawings.

   c. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.4 EXISTING SYSTEMS AND CONDITIONS

A. Prior to beginning work inspect and test all existing electrical systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.

3.5 Contractor shall be responsible for maintaining existing systems included systems in the drawing, and equipment throughout the duration of the project including repairing/replacing of any damaged components, maintaining system power, system wiring, etc. and return system back to owner at completion of project in same conditions and operational capacity. The contractor shall also be responsible for cleaning existing equipment from any and all debris accumulated throughout the duration of the project. Where required, the contractor shall provide a constructed barrier of an approved material and construction type that will limit the accumulation of debris and not hinder or impede the operation of the equipment still in use during construction. ELECTRICAL INSTALLATIONS

A. All installations shall comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.

2. The architect shall control the placement of all wall and ceiling mounted electrical equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.

3. Verify all dimensions with field measurements.

4. Arrange for all chases, slots and openings in other building components that are not indicated on drawings, to allow for electrical installations.

5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.

7. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

8. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.

9. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the owners representative.

12. All finished equipment surfaces damaged during construction shall be brought to “as new” condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.

13. Workmanship shall be as called for in the “Standard of Installation” published by the National Electrical Contractors Association (NECA).

14. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

15. No electrical equipment shall be hidden or covered up prior to inspection by the owners representative. All work that is determined to be unsatisfactory shall be corrected immediately.

16. All electrical work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

17. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building as practical. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his/her approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance. This coordination applies to finished and unfinished areas of the project.

18. Install access panel or door where units are concealed behind finished surfaces.

3.6 PAINTING

A. This Contract Includes the following :

1. Painting for all cut and patch work performed as part of Division 26, 27, and 28 contract.

2. Painting required for touch-up of surfaces damaged due to the installation of electrical work.

3. Painting as required to repair finish of equipment furnished.

4. Painting of all surface mounted raceways in finished areas.

5. Painting of conduit in finished areas, outside of mechanical spaces.

3.7 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest version of the National Electrical Code.

B. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts.

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to rough-in.

3.8 CLEANING

A. After all tests are made and installations completed satisfactorily:

1. Thoroughly clean entire installation, both exposed surfaces and interiors.

2. Remove all debris caused by work.

3. Remove tools, surplus, materials, when work is finally accepted.

3.9 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical/electrical facilities or services.

3.10 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owners designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide, operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer's certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e., variable frequency drive and air handling unit) both manufacturer's shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Refer to Division 01 Specification Section 019113 – Commissioning Requirements for additional startup and Contract Closeout requirements.

3.11 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions, warranty, Maintenance Agreement, Test and inspections, and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer Representative and service agency for all major equipment items. Bind above items in a three ring binder with name of project on the cover. Provide required number of hard copies and disk(s) containing pdf files of all documents and deliver to Owner's Representative before request for acceptance.

3.12 RECORD DOCUMENTS

A. Prepare record or as-built documents in accordance with Division 01 Specifications. In addition to those requirements provide the following:

1. Document the routing major raceway systems, location of control devices, branch circuit numbers for all devices and equipment and fuse and circuit breaker sizes for major equipment and branch circuit home runs.

2. Provide stamp on each drawings including: Company Name, Date and "Record Drawings"

3. Refer to each Division 26, 27 and 28 section for additional items to be included in the record drawings.

4. Provide required number of hard copies (refer to Division 01) and disk(s) containing pdf files of all documents.

3.13 REMOVALS

A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl spaces and roofs to determine total Scope of Work.

B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all equipment, conduit, junction boxes, devices, panels, and all hangers, including the top connection and any fastenings to building structural systems. Patch, paint and seal all removals, openings and other penetrations in roof, walls, ceilings, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

C. Project drawings have been produced from record drawings and general field verification. Reasonable attempt has been made to identify all required demolition and extent of new work. However, all existing equipment / devices may not be shown due to interferences and restricted access. Before commencing work, inspect the entire project area. Verify with the Owner’s Representative all equipment / devices being removed or being replaced.

D. The electrical contractor shall review all demolition and installation drawings from each trade and include in his bid any electrical demolition required by other trades.

E. Remove existing devices and lighting circuiting where indicated to facilitate renovations. Remove circuiting to source or nearest junction box clear of construction when feeding other devices. Revise existing wiring as required to ensure all downstream devices remain operational. All splices shall be accessible per NEC requirements.

F. Prior to de-energizing an existing circuit, field verify that other areas outside the area of work will not be impacted. Provide specified temporary power to loads as deemed necessary by the facility and the Owner’s representative.

3.14 HAZARDOUS MATERIALS RECOGNITION AND PRECAUTIONS

A. Hazardous materials include by not limited to ACM, LEAD and MOLD.

B. The contractor shall be responsible for coordination of all required removal work, coring,

cutting and patching with the owners asbestos management plan. Prior to performing such work identify areas containing hazardous materials. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the hazardous materials management plan. Refer to Division 1 sections for further requirements.

C. The disturbance or dislocation of hazardous materials causes materials to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized Hazardous material - controlled work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

D. Refer to division 2 sections for further requirements.

3.15 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre designated site.

B. Items normally accepted as salvage by the Owner:

1. Non PCB contaminated transformers, oil filled or dry.
2. Meters, meter sockets and test switches.
3. All deadfront switchgear.
4. All three phase circuit breaker panelboards and covers.
5. Circuit breakers.
6. Disconnects (100 AMP and up).
7. Bus duct and apparatus.
8. Luminaires.
9. Fire protection equipment.
10. Nurse call and intercom.
11. Motors above 1/2 HP and up.
12. Environmental and automation control equipment.

13. Telephones.

14. Central clock system.

C. DISPOSAL

1. All removed material shall be disposed of properly in accordance with the United States Environmental Protection Agency rules and regulations.

2. Disposal of HID and fluorescent lamps shall be treated as hazardous waste.

**END OF SECTION 260010**

SECTION 260100 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SCOPE

A. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:

1. Miscellaneous Supports

2. Access Doors and Panels

3. Fire Stopping

4. Boxes and Cabinets

5. Equipment Pads, Bases and Supporting Devices

6. Identification

7. Potential and Arc Flash Hazard Labeling

1.2 SUBMITTALS

A. Product data for:

1. Boxes and cabinets

2. Fire Stopping Materials

3. Coordination drawings for sleeves, access panels, and door locations.

1.3 QUALITY ASSURANCE

A. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, and cutting and patching.

B. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

C. Materials specified herein shall comply with the applicable requirements of :

1. The following Articles of the National Electric Code (NFPA 70)

a. 314 - Outlet, Device, Pull and Junction Boxes, Conduit bodies and fittings

b. 312 - Cabinets, Cutout Boxes and Meter socket Enclosures

PART 2 - PRODUCTS

2.1 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:

1. Steel plates, shapes, bars, and grating - ASTM A 36

2. Cold-Formed Steel Tubing - ASTM A 500

3. Hot - Rolled Steel Tubing - ASTM A 501

4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal Fasteners shall be Zinc-coated (type, grade and class as required)

2.2 ACCESS DOORS AND PANELS

A. Steel access doors and frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Construction:

1. Frames:

a. 16 gage steel with 1 inch wide exposed perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast in place concrete, ceramic tile.

b. 16-gage steel, perforated flanges with bead for gypsum or plaster wall board.

c. 16-gage steel with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.

2. Access Doors:

a. Provide 14 gage sheet steel flush panel doors with concealed continuous piano hinge factory installed, primed and painted, set to open 175 degrees.

b. Provide fire rated, insulated flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1 ½ hour “B” labeled, in fire

rated partitions.

C. Provide flush, screwdriver operated cam locks on all access doors.

2.3 FIRE STOPPING – Coordinate with Architect and Project led DASNY, SUCF, OGS

A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:

1. Dow Corning Fire-Stop System Foams and Sealants.

2. Nelson Electric Fire-Stop System Putty, CLK and WRP.

3. Thomas & Betts - S-100 FS500/600.

4. Carborundum Fyre Putty.

5. Hilti Firestop Systems.

2.4 BOXES AND CABINETS

A. Outlet Boxes and Covers

1. General Use Boxes shall be galvanized steel, not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

2. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

3. Acceptable manufacturers:

a. Steel City

b. Raco

c. Appleton

d. Crouse Hinds

B. Pull and Junction Boxes

1. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

2. Acceptable manufacturers:

a. Hoffman

b. Keystone

c. Cooper B-Line

d. Custom fabricated per. NEC and UL guidelines

3. Flush floor junction boxes shall be recessed cover boxes designed for flush mounting in masonry. Provide checkered plate gasketed cover suitable for foot traffic. Make: O.Z. Gedney Type YR or approved equal.

C. Terminal and Equipment Cabinets:

1. Terminal and Equipment Cabinets shall be code gauge galvanized steel with removable endwalls. Fronts shall be of code gauge steel, flush or surface type (as indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be U.L. listed and shall be minimum 35"H x 24"W x 6"D. Provide removable insulated plywood terminal board mounted on inside back wall of cabinet.

2. Acceptable manufacturer:

a. Square D "Mono-Flat"

b. Approved equal

2.5 EQUIPMENT BASES, PADS AND SUPPORTING DEVICES

A. Supports, support hardware and fasteners shall be protected with zinc coating or treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic. Products used for outdoor applications shall be hot dipped galvanized.

B. Provide clevis hangers, riser clamps, conduit straps, threaded c clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps as applicable.

C. 14 gauge U-Channel systems with 9/16 inch diameter holes at a minimum of 1 7/8 inches on center in the top surface. Provide fittings and accessories that match and mate channel.

D. Provide carbon steel or wedge or sleeve type expansion anchors, steel spring head toggle bolts and heat treated steel power driven threaded stud fastening equipment as required by construction types.

E. Provided field fabricated supporting devices such as angles, channels, pipe supports, etc. All fabricated supports shall be of metal construction.

F. Acceptable Manufacturers:

1. Allied Tube
2. American Electric
3. B-Line
4. Unistrut Diversified Products
5. Cooper Industries
6. Killark Electric Mfg. Co.
7. O/Z Gedney
8. Spring City Electrical Mfg. Co.
9. Thomas & Betts Corporation

2.6 ROOF PENETRATION FLASHING AND SEALING

A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of contract. Provide non-ferrous flashing pieces, EDPM skirts, EDPM hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Design Equipment: RPS.

C. Acceptable Manufacturers: Pate, Shipman & Son.

2.7 IDENTIFICATION

A. Equipment Labeling

1. Provide adhesive marking labels for raceway and metal-clad cable. The labels shall indicate voltage and service, and be located above ceilings every 75 feet and on wall mounted conduit in mechanical and equipment rooms.

2. Provide colored self-adhesive vinyl tape, minimum 3 mils thick by 1 inch wide for all phase marking on cable.

3. Provide 6-inch wide bright colored continuously printed, plastic tape compounded for direct-burial services. Printing shall indicate service below.

4. Provide engraved, plastic laminated labels, signs and instruction plates. Engraving stock melamine plastic laminate. Use 1/16-inch minimum thick for signs up to 20 square inches or 8 inches in length. Use 1/8 inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners. Emergency equipment shall have red face.

2.8 POTENTIAL AND ARC FLASH HAZARD LABELING

A. Provide multi-colored self-adhesive vinyl label, minimum dimension 5” wide x 3” high.

B. Shall designate the potential and arc flash hazard for equipment according to NFPA-70E.

C. Label shall include the following information:

1. “ARC FLASH & SHOCK HAZARD APPROPRIATE PPE REQUIRED”

2. Flash Hazard Category

3. Flash protection Boundary

4. List of required personal protective equipment (PPE)

5. Voltage of max. present shock hazard

6. Limited, Prohibited, and Restricted approach boundaries

D. Acceptable Manufacturers:

1. W.H. Brady Co.

2. Markal Corp.

3. National Band & Tag Company

4. Panduit Corporation

5. Cole-Flex Corporation

PART 3 - EXECUTION

3.1 ACCESS DOORS AND PANELS

A. Install access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, duct mounted fire alarm detectors and other electrical equipment requiring access for maintenance or operation.

B. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.2 FIRE STOPPING

A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:

1. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.

2. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

3. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

4. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.3 BOXES AND CABINETS

A. Consider location of outlets shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls.

B. Outlet boxes in separate rooms shall not be installed "back-to-back" without the approval

of the Owner's Representative.

C. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.

D. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers.

E. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2" deep boxes with square corners and dimensions to accommodate conductors installed.

F. Surface ceiling mounted outlet boxes shall be minimum 4" square, 1-1/2" deep, galvanized sheet metal.

G. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.

H. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet or tile, provide floor outlet with proper flange.

I. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as required by the National Electrical Code.

3.4 OUTLET BOX ROUGH-IN HEIGHTS:

A. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline except fire alarm as follows:

| | | |
|---|---|---|
| 1. | Toggle switches | 46" |
| 2. | Receptacle outlets | 18" |
| 3. | Receptacle outlets, above hot water or steam baseboard heaters. | |
| | Do not install receptacle outlets above electric baseboard heaters. | 30" |
| 4. | Receptacle outlets, hazardous and mechanical areas<br>designer edit for preference | 48" |
| 5. | Receptacle outlets, weatherproof, above-grade | 24" |
| 6. | Exterior receptacle<br>Designer Edit | 36” |
| 7. | Clock outlets | 90" |

| | | |
|---|---|---|
| 8. | Telephone outlets | 18" |
| 9. | Telephone outlets, wall mounted | 46" |
| 10. | T.V. outlet | 18" |
| 11. | Fire alarm manual station (top of device) | 46" |
| 12. | Fire alarm audio/visual (bottom of device) | 80" |
| 13. | Branch circuit panelboards, to top of backbox | 72" |
| 14. | Distribution panelboards, to top of backbox | 72" |
| 15. | Terminal cabinets, control cabinets | 72" |
| 16. | Disconnect switches, motor starters, enclosed circuit breakers | 48" |

17. Where structural or other interference's prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.

3.5 EQUIPMENT PADS, BASES AND SUPPORTING DEVICES

A. Hangers and Supports:

1. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.

2. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports.

3. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Provide a minimum of one ½" rebar dowel for every 2 sq. ft. of base area, anchored 2" into floor and base, to eliminate movement. Bases shall be 4" high (unless otherwise indicated); shape and size to accommodate equipment, to extend 4" beyond equipment footprint in all directions. Set anchor bolts in sleeves before pouring. After anchoring and leveling, fill equipment bases with grout

3.6 IDENTIFICATION

A. Provide engraved lamicoid identification nameplates on main switchboard and on all panelboards using designation shown in panelboard schedule.

B. Provide engraved lamicoid identification nameplates for each circuit breaker in the main distribution panel listing the panelboard or equipment connected to each device.

C. Provide engraved lamicoid identification nameplate on individual circuit breaker enclosures, motor starters and disconnect switches, listing the equipment connected to the particular device, feeder panelboard and feeder circuit number.

D. Provide complete type written directory for each panelboard listing room number, function, etc., for each circuit breaker. Provide type written updated panelboard directories for existing panelboards affected by this work.

E. Panelboard nameplates shall be engraved White, with black core, with Helvetica medium 3/16" lettering.

F. Identify junction and pullboxes for particular service such as power, lighting, fire alarm, telephone, intercom, public address, nurse call, etc. using stencil lettering on cover.

G. Provide painted or colored junction box covers as outlined below for system wiring contained within:

1. Power – Blue
2. Lighting – Green
3. HVAC – Orange
4. Security – Yellow
5. Fire Alarm - Red

H. Provide a tape label on all receptacle and switch coverplates, power poles, etc. listing panel designation and circuit number. Tape shall be attached to outside of receptacle or switch coverplates.

I. Provide potential and arc hazard labeling on all new switchboards, panelboards, industrial control panels, motor control centers.

3.7 ELECTRICAL VOLTAGE AND ARC FLASH HAZARDS AND LABELING

A. Contractor shall review all existing conditions regarding flash and potential hazards at panelboards, switchboards, motor control equipment, starters, and safety switches. All personal shall be trained and suited in proper protective clothing and equipment suitable for installation.

B. Provide potential hazard and arc flash hazard labeling of all new and modified panelboards, switchboards, motor control equipment, starters, and safety switches.

3.8 FLASHING AND SEALING

A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond.

Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of contract. Provide non-ferrous flashing pieces, EDPM skirts, EDPM hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

3.9 CUTTING AND PATCHING

A. Work shall be in accordance with Section 017329 - Cutting and Patching.

B. In addition to the requirements of Section 017329 the following requirements apply:

1. Perform cutting, fitting and patching of electrical equipment in all following cases:

a. To uncover work for installation of poorly coordinated or ill-timed electrical work.

b. To remove and replace defective work.

c. To remove and replace work not conforming to requirements of the Contract Documents.

2. Remove samples of installed work as specified for testing.

3. Install equipment and materials in existing structures.

4. Cut, remove and legally dispose of all electrical equipment, components, and materials as called for and all other items not indicated on plans but made obsolete by the installation of new work.

5. Protect the structure, furnishings, finishes and adjacent materials not being removed and maintain temporary

END OF SECTION 260100

SECTION 260519 - LOW-VOLTAGE CABLES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 SCOPE

A. This section includes minimum requirements for the following:

1. Low Voltage Conductors
2. Type MC Metal Clad Cable
3. Type MC metal Clad Cable with Control/signal cable
4. Connectors and Terminations

1.3 SUBMITTALS

A. Provide product data for the following:

1. Low Voltage Conductors
2. Type MC Metal Clad Cable
3. Connectors and Terminations

1.4 QUALITY ASSURANCE

A. All conductors shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of :

1. The following Articles of the National Electric Code (NFPA 70)
   a. 300 - Wiring Methods
   b. 310 - Conductors for General Wiring
   c. 330 - Type MC Metal Clad Cable
   d. 400 - Flexible Cords and Cables

e. 402 - Fixture Wires

2. The following U.L. Standards:

a. UL 83 Thermoplastic-Insulated Wires and Cables

b. UL 44 Thermoset-insulated Wires and Cables

c. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.

d. UL 1277 Electrical Power and Control Tray Cables

e. UL 6, 1981 Rigid Metal Electrical Conduit

f. All Other Applicable Standards

PART 2 - PRODUCTS

2.1 GENERAL FOR ALL CONDUCTORS

A. Branch circuits rated 100amp and less shall base the conductor's ampacity rating on the 60deg C column per NEC table 310.15.

B. Branch circuits rated over a 100amp shall base the conductor's ampacity rating on the 75deg C column per NEC table 310.15.

C. Neutral conductors shall be considered current carrying conductors per NEC 310.15.C.E

2.2 LOW VOLTAGE CONDUCTORS

A. General purpose feeder and branch circuit and control wiring:

1. Annealed Copper, 98% conductivity.

2. Minimum wire size:

a. #12 AWG for branch circuits

b. #14 AWG for control and signal circuits

3. Wire #8 AWG and up shall be stranded per ASTM B8. Designer note, specify correct tooling for installing

4. 600 volt insulation for all wiring above 50 volts.

5. 300 volt insulation permitted for all wiring below 50 volts.

6. Thermal plastic with PVC insulation with nylon jacket.

7. Suitable for wet or dry locations, THHN/THWN-2 90 degree Celsius.

8. 90 degree C maximum operating temperature rating.

9. UL 83 Listed

B. Flexible Power Cords:

1. Shall be Type SOOW, designed for extra hard use.

2. Manufactured using tinned flexible stranded Class K copper conductors, and heat, moisture and oil resistant EPDM Black rubber insulated Jacket. Rated -40°C to 90°C

3. 90°C, 600 Volts. Flexible Stranding. Water Resistant 60°C

4. Available from 2 to 5 conductors, 14AWG to #6AWG

5. Design Make: General Cable Carol Brand

6. Acceptable Manufacturers:

a. Southwire

b. Allied

c. Approved Equal

C. Color Coding

1. All circuits shall be color coded according to the following schedule:

| Voltage | A PHASE | B PHASE | C PHASE | NEUTRAL |
|---|---|---|---|---|
| 208Y/120V, 3 Phase | Black | Red | Blue | White |
| 480Y/277V, 3 Phase | Brown | Orange | Yellow | Gray |
| 240/120V, 1 Phase | Black | Red | | White |

*ALL GROUNDING CONDUCTORS SHALL BE GREEN

2. All isolation panel branch circuits shall be color coded according to the following schedule:

| Voltage | Isolated Cond. 1 | Isolated Cond. 2 | Isolated Cond. 3 |
|---|---|---|---|
| 1-ø circuit | Orange w/ stripe* | Brown w/ stripe* | N/A |
| 3-ø circuit | Orange w/ stripe* | Brown w/ stripe* | Yellow w/ stripe* |

*STRIPE COLOR IN ACCORDANCE WITH NEC ARTICLE 517.160

3. #6 AWG and smaller shall have insulation continuously colored as called for above.

4. #4 AWG and larger may by identified using a minimum 3” tape band.

5. Color code all conductors at all pullboxes, enclosures, and terminations.

6. Switched legs shall be identified with the same color insulation as the phase leg.

D. Acceptable Manufacturers:

1. General Cable
2. Southwire
3. Okonite
4. Prysmian

2.3 TYPE MC METAL CLAD CABLE

A. Construction:

1. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible Aluminum tape.
2. Single Circuit.
3. Suitable for wet or dry locations.
4. Suitable for cable tray installations.
5. Do not install direct buried, in concrete, or in the presence of corrosive vapors.
6. Provide with separate integral insulated grounding conductor.
7. Support within 18” of every junction box, and or every 6 feet.
8. Manufactured and installed in accordance with NEC Article 330.
9. Comply with UL 1569.
10. Design Make: Same as building wire.

2.4 TYPE MC METAL CLAD CABLE with CONTROL/SIGNAL CABLE

A. Construction:

1. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible Aluminum tape.
2. Yellow strip/blocks printed on outside of the armor indicating conductors contained
3. 16/2 AWG copper TFN insulated single conductors
4. Single Circuit.
5. Suitable for wet or dry locations.

6. Suitable for cable tray installations.

7. Do not install direct buried, in concrete, or in the presence of corrosive vapors.

8. Provide with separate integral insulated grounding conductor.

9. Support within 18" of every junction box, and or every 6 feet.

10. Manufactured and installed in accordance with NEC Article 330.

11. Comply with UL 1569.

12. Design Make: Same as building wire.

2.5 LOW VOLTAGE CONNECTORS AND TERMINATIONS

A. Straight Splices, #26 AWG To #10 AWG

1. Nylon Insulated compression butt-splices.

2. 600 volt, 90 degree C rated.

3. Make: Burndy "Insulink", T&B "Sta-Kon", or approved equal

B. Straight Splices, #8 AWG and Larger

1. Two way, long barrel, compression type, copper

2. Provide heat shrink tubing over splice.

3. 600 volt rated.

4. Make: Burndy "Hylink", T&N 54800 Series, or approved equal.

C. Pigtail Splices, #26 AWG to #10 AWG

1. Twist type pressure connector.

2. 600 volt rated, 105 degree C.

3. Size as required for number and size of conductors used.

4. Make: T&B Scotchlock, or approved equal

D. Three Way Splices, #8 AWG and Larger

1. Three way, long barrel, compression type, copper.

2. Provide tape or heat shrink tubing over splice.

3. 600 volt rated.

4. Make: Burndy “Hylink”, T&B 54700 Series, or approved equal.

E. Lug Terminations for Control and Signal Wiring.

1. Nylon insulated fork with compression termination of #26 AWG to #10 AWG.

2. Nylon insulated ring with compression termination for #8 AWG and larger.

3. 300 volt rated.

4. Make: Burndy “Insulug”, T&B “Sta-Kon”, or approved equal.

F. Lug Terminations for Power Wiring

1. Long barrel, compression type, copper body, on hole for #8 AWG to #2/0 AWG.

2. Long barrel, compression type, copper body, two hole, for #3/0 AWG and larger.

3. 600 volt rated.

4. Make:

a. One-hole lug: Burndy “Hylug”, T&B 54900 Series, or approved equal.

b. Two-hole lug: Burndy “Hylug”, T&B 54800 Series, or approved equal.

PART 3 - EXECUTION

3.1 LOW VOLTAGE WIRE AND CABLE

A. GENERAL

1. Install cables in raceway as called for after the entire raceway system has been completed.

2. Minimum size for power wiring shall be #12AWG.

3. Minimum size for control wiring shall be #14AWG, except 24 volt and below. All control wiring shall be stranded.

4. Shared neutral conductors are not permitted. Each branch circuit phase conductor shall be paired with a dedicated neutral conductor along the entire length, including branch circuits for light fixtures.

5. Aluminum conductors will not be permitted.

6. All runs over 100 feet; conductors shall be up sized by one size.

7. Install splices and connections in accessible outlet, pull, and junction boxes.

8. Insulate all splices and connections with UL Labeled plastic tape, heat shrink

tubing, or plastic molded caps.

9. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.

10. Provide insulated green jacket grounding conductor in each raceway.

11. Provide dedicated white jacket insulated neutral conductor for each individual branch circuit. Shared neutrals are not acceptable.

12. Adhere to NEC de-rating requirements for raceway fill.

13. Provide stranded wire to motors, transformers, equipment, and vibrating machinery.

14. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.

15. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

| Application | Cable Types | Design Make |
|---|---|---|
| General Purpose Construction & Maintenance | Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon | Ideal – Yellow 77 |
| High Temperature Construction & Maintenance | Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket | Ideal – Yellow 190 |
| Utility Construction & Maintenance | Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket | Aqua – Gel II |
| Cold Weather Construction & Maintenance | Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket | Aqua – Gel CW |

16. Use pulling means including fish tape, cable, rope and basket type grips which will not damage cables or raceways. Use approved mechanical pullers for feeders and branch circuits as required for #6 AWG cable and larger. Do not use mechanical means to pull conductors No. 8 or smaller.

17. Branch circuit conductors installed in panelboards, and control conductors

installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.

18. Reconnect branch circuit wiring at panelboards as required to obtain a balanced three phase load on the feeders.

19. Provide conduit seals in explosion proof areas as called for on the plans and as required by the National Electrical Code.

3.2 TYPE MC METAL CLAD CABLE(S)

A. MC cable shall only be permitted for use in 6-feet max. whips from junction boxes above accessible ceiling areas to recessed light fixtures.

B. Type MC cable may not be used for home runs to panelboards.

C. Type MC cable may not be used for and emergency branch circuits per. Article 517 in the NEC.

D. Support cable per. NEC. Secure the cable to fixture hangers using nylon or plastic ties.

E. Bending radius shall comply with Article 330.24 of the NEC.

F. Provide insulating bushing at all termination points between the metal sheath and outlet or junction box.

G. Type MC cable shall not be installed exposed.

3.3 CONNECTORS AND TERMINATIONS

A. Cover un-insulated splices, joints, and free ends of conductor with rubber friction tape or PVC electrical tape. Plastic insulating caps may serve as insulation.

3.4 TESTS

A. Low Voltage Feeders

1. After low voltage feeders are pulled in, and before being connected, test feeders with a 1000 volt, 60 Hz insulation tester for one minute to determine that the conductor insulation to ground is greater than that recommended by the manufacturer.

END OF SECTION 260519

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a complete grounding system meeting or exceeding the requirements of Article 250 of the latest National Electrical Code. Install all raceway systems, including metal conduit, wireways, pullboxes, junction boxes, bus ducts, enclosures, and motors, to provide a continuous ground path with the lowest possible impedance.

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Conductors

2. Ground Rods

3. Molded Fusion Welds

4. Hardware

1.3 QUALITY ASSURANCE

A. All grounding systems shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:

1. The National Electrical Code, Article 250.

1.4 SUBMITTALS

A. Provide product data for the following:

1. Ground Rods

2. Grounding System Test Reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids,

shunts, etc., shall be bare copper unless otherwise called for.

B. Conductors shall be copper, as called for in Specification Section 260519 - Low Voltage Cables.

C. Provide conductors with THHN/THWN insulation. Sizes #10 AWG and smaller shall be green in color. Conductor sizes #8 AWG and larger may have green taped bands at each end, and in all pullboxes.

D. Acceptable Manufacturers:

1. Same as for low-voltage conductors. Refer to Specification Section 260519 – Low Voltage Cables.

2.2 GROUND RODS

A. Solid copper or copper clad steel cylindrical rods, 5/8 in. minimum diameter, minimum 8 ft. long.

B. Acceptable Manufacturers:

1. Erico or Approved Equal

2.3 CONNECTORS, CLAMPS, TERMINALS

A. General: Connectors specified are part of a system. Furnish connectors and components, and use specific tools and methods as recommended by connector manufacturer to form complete connector system.

B. Splices:

1. Spring Type (for #10AWG conductors and smaller only):

a. Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s B-Cap, Electrical Products Div./3M's Scotchlok Type Y, R, G, B, O/B+, R/Y+, or B/G+, or Ideal Industries Inc.'s Wing Nuts or Wire Nuts.

2. Indent Type with Insulating Jacket:

a. Rated 150° C, 600V; Ideal Industries Inc.'s High Temperature Wire-Nut Model 73B, 59B.

b. Indent Type with Insulating Jacket: Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s Crimp Connectors, Ideal Industries Inc.'s Crimp Connectors, Penn-Union Corp.'s Penn-Crimps, or Thomas & Betts Corp.'s STA-KON.

c. Indent Type (Uninsulated): Anderson/Hubbell's Versa-Crimp, VERSAtile, Blackburn/T&B Corp.'s Color-Coded Compression Connectors, Electrical Products Div./3M's Scotchlok 10000, 11000

Series, Framatome Connectors/Burndy's Hydent, Penn-Union Corp.'s BCU, BBCU Series, or Thomas & Betts Corp.'s Compression Connectors.

3. Connector Blocks: NIS Industries Inc.'s Polaris System, or Thomas & Betts Corp.'s Blackburn AMT Series.

4. Resin Splice Kits: Electrical Products Div./3M's Scotchcast Brand Kit Nos. 82A Series, 82-B1 or 90-B1, or Scotchcast Brand Resin Pressure Splicing Method.

5. Heat Shrinkable Splices: Electrical Products Div./3M's ITCSN, Raychem Corp.'s Thermofit Type WCS, or Thomas & Betts Corp.'s SHRINK-KON Insulators.

6. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.

7. Gutter Taps: Anderson/Hubbell's GP/GT with GTC Series Covers, Blackburn/T&B Corp.'s H-Tap Type CF with Type C Covers, Framatome Connectors/Burndy's Polytap KPU-AC, H-Crimpit Type YH with CF-FR Series Covers, ILSCO's GTA Series with GTC Series Covers, Ideal Industries Inc.'s Power-Connect GP, GT Series with GIC covers, NSI Industries Inc.'s Polaris System, OZ/Gedney Co.'s PMX or PT with PMXC, PTC Covers, Penn-Union Corp.'s CDT Series, or Thomas & Betts Corp.'s Color-Keyed H Tap CHT with HTC Covers.

8. Lugs:

   a. Single Cable (Compression Type Lugs): Copper, one or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, NSI Industries Inc.'s L, LN Series, Penn-Union Corp.'s BBLU Series, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.

   b. Single Cable (Mechanical Type Lugs): Copper, one or 2 hole style (to suit conditions); Blackburn/T&B Corp.'s Color-Keyed Locktite Series, Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Locktite Series.

9. Acceptable Manufacturers:

   a. Burndy

   b. T & B

   c. Erico

PART 3 - EXECUTION

3.1 INSTALLATION

A. Service Entrance

1. Solidly ground the electrical service at the service entrance. Provide a grounding electrode conductor from the service entrance ground bus to all of the following grounding electrodes:

a. Metal water pipe, ahead of the meter.

b. Building steel

c. Made grounding electrode grid.

d. Concrete encased electrode (steel rebar in foundation)

2. For a grounded electric service, solidly connect the grounded (neutral) conductor to the service entrance ground bus. Do NOT make any grounding connections to any grounded conductors on the load side of the service disconnecting means.

3. Provide a bare, copper, #4/0 bonding jumper across the water meter.

B. Raceway Systems:

1. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250-122.

2. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.

3. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250-122. Connect the bonding jumper between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.

4. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250-122 for all conduit expansion joints.

5. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250-122.

6. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250-122.

7. Provide isolated ground conductors of systems as called for on the plans.

C. Ground Grid:

1. Provide 3 ground rods, 8 feet long, driven on 10 foot centers, with top of rod 12 inches below finished grade, and located as called for on plans.

2. Connect with size #4/0 AWG copper conductors as called for.

3. Connecting conductors shall be located within 6 inches of the top of the ground rod.

4. Provide two size #4/0 AWG grounding conductors from the ground grid to the service entrance ground bus.

5. Provide one size #4/0 AWG grounding conductor from the ground grid or service entrance ground bus to the service side of nearest metallic cold water and/or sprinkler main.

6. Provide one size #4/0 AWG grounding conductor from the ground grid or service entrance ground bus to building steel.

7. Provide molded fusion welds for all below grade connections. Molds shall be new, unused, and shall be replaced when worn or broken.

D. Primary Electrical Equipment:

1. Transformers:

a. Provide two bare #4/0 AWG conductors, one from each of two ground buses, to ground.

b. Provide one size #4/0 AWG conductor from each air terminal chamber to ground bus.

c. Provide a grounding conductor from the neutral bushing or bushings to system ground, sized as called for, or in accordance with NEC Table 250-122, whichever is of greater capacity.

d. System ground conductors, usually run with phase conductors, shall be connected to the ground bus.

2. Metal Enclosed Switchgear:

a. Two size #4/0 AWG grounding conductors from the ground bus to ground or one size #4/0 AWG ground circuit from ground bus to ground for each two compartments in continuous line-up equipment, whichever is the greater number.

b. System ground conductors, usually run with phase conductors, shall be connected to the ground bus.

c. Where metal enclosures are pierced or penetrated to accommodate ground conductors, seal opening around ground conductor to metal enclosure with "Duxseal" to maintain enclosure integrity.

E. Secondary Electrical Systems:

1. Solidly ground all transformer neutral conductors and enclosures to building steel, or a cold water pipe 1” or larger in size as called for in Table 250-122 of the National Electrical Code.

2. Provide an equipment grounding conductor from the point of termination back to the ground bus of the serving panelboard, switchboard, or transformer. Do not splice equipment grounding conductors.

3. Provide an equipment grounding conductors from the point of termination back to the ground bus of the serving panelboard, switchboard, transformer, or switchgear.

4. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

F. Medium Voltage Conductors:

1. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

2. The grounding conductor contained in raceway systems shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

3. The grounding shield tape or concentric wire shields on cables shall be circuited to system ground; ground at each splice and termination.

G. Grounding:

1. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:

a. For grounding of 5 KV equipment, enclosures,

and cable shields: 10 Ohms

b. For grounding secondary service neutral: 25 Ohms

c. For grounding non-current carrying metal parts associated with secondary distribution system: 25 Ohms

2. Providing grounding tests to verify the above values. Add additional ground rods or connections in order to meet these values.

END OF SECTION 260526

SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Galvanized Rigid Steel Conduit (GRS)
2. Electrical Metallic Tubing (EMT)
3. Flexible Metal Conduit
4. Liquidtight Metal Flexible Conduit
5. Innerduct/Electrical Non-Metallic Tubing (ENT)
6. Rigid Non-Metallic Conduit – Smooth Wall
7. Fittings and Conduit Bodies
8. Expansion Fittings
9. Surface Metal Raceway
10. Surface Non-Metallic Raceway
11. Power/Communications Poles
12. Wireways
13. Cable Tray
14. Cable Hangers

1.3 QUALITY ASSURANCE

A. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)

   a. Wiring Methods

   b. Cable Trays

   c. Electrical Nonmetallic Tubing

   d. Nonmetallic underground conduit with conductors

   e. Rigid metal conduit

   f. Rigid nonmetallic conduit

   g. Electrical metallic tubing

   h. Flexible metallic tubing

   i. Flexible metal conduit

   j. Liquidtight Flexible metal conduit and Liquidtight flexible nonmetallic conduit.

   k. Surface Metal Raceways and Surface Nonmetallic raceways

   l. Metal wireways and nonmetallic Wireways

   m. Outlet, Device, Pull and Junction Boxes, Conduit Bodies and Fittings

   n. Auxiliary gutters

2. The following National Electrical Manufacturers Association (NEMA) Standards:

| | |
|---|---|
| NEMA, RN1 | PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit. |
| NEMA, TC 3 | PVC fittings for use with Rigid PVC Conduit and tubing. |
| NEMA, TC 6 & TC 8 | PVC Plastic Utilities for Underground Installation. |
| NEMA, TC 9 & TC 10 | Fittings for PVC Plastic Utilities Duct for Underground Installation. |

3. The following American National Standards Institute (ANSI) standards:

| | |
|---|---|
| ANSI-C80.1 | Electric Rigid Steel Conduit |
| ANSI-C80.3 | Specification for Electrical Metallic Tubing, Steel |

4. The following U.L. Standards:

| | |
|---|---|
| UL 1 | Flexible Metal Electrical Conduit |
| UL 3 | Flexible Nonmetallic Tubing for Electric Wiring |
| UL 5 | Surface Metal Raceways and Fittings |

| | |
|---|---|
| UL 6 | Electrical Conduit Rigid Metal Conduit, Steel |
| UL 360 | Liquidtight Flexible Metal Conduit |
| UL 514B | Conduit, Tubing and Cable Fittings |
| UL 651 | Schedule 40, 80, Type EB and A Rigid PVC |
| UL 797 | Electrical Metallic Tubing, Steel |
| UL 870 | Wireways, Auxilliary Gutters and Associated |

1.4 SUBMITTALS

A. Provide product data for the following:

1. Raceways
2. Fittings and Accessories
3. Surface Raceway
4. Cable Trays
5. Cable Hangers

PART 2 - PRODUCTS

2.1 CONDUIT

A. Galvanized Rigid Steel Conduit

1. Shall be hot-dipped galvanized steel, including threads.
2. Acceptable manufacturers:
    a. LTV Steel
    b. Triangle
    c. Allied Tube
    d. Steel Duct
    e. Wheatland

B. Electrical Metallic Tubing

1. Electrical Metallic Tubing shall be electro-galvanized steel.
2. Acceptable manufacturers:
    a. Triangle
    b. Wheatland
    c. Allied Tube
    d. Steel Duct
    e. LTV Steel

C. Flexible Metal Conduit

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges.

2. Acceptable manufacturers:

a. Anaconda

b. American Flexible Conduit Co.

c. O-Z/Gedney

d. Thomas and Betts

D. Liquidtight Flexible Metal Conduit

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocking zinc coated strip steel. Interior surfaces shall be free from burrs and sharp edges. Provide with a liquid-tight jacket of flexible polyvinyl chloride (PVC).

2. Acceptable Manufacturers:

a. Allied

b. American Flexible Conduit

c. Carlon

d. Thomas and Betts

E. Innerduct/Electrical Non-Metallic Tubing (ENT)

1. This may also be referenced as Innerduct in the contract documents.

2. Size: 1 ¼" diameter corrugated wall flexible tubing unless otherwise indicated on drawings.

3. Shall be UL Listed type CMP (plenum rated), CMR (riser rated), or CMG (general purpose) as required for the installation.

4. Acceptable Manufacturers:

a. Carlon

b. Dura - Line

c. Arnco

d. VikiMatic

F. Rigid Non-Metallic PVC Conduit

1. Extra-Heavy wall conduit: Schedule 80, constructed of polyvinyl chloride, rated for use with 90 degree C conductors, and UL listed for direct burial and normal

above ground use.

2. Heavy wall conduit: Schedule 40, constructed of polyvinyl chloride, rated for use with 90 degree C conductors, and UL listed for direct burial and normal above ground use.

3. Acceptable manufacturers:

   a. Carlon

   b. Thomas & Betts

   c. Certainteed

   d. Condux

G. Fittings

1. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.

2. Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.

3. Fittings for flexible metal conduit shall be center stopped, insulated throat, U.L. E-11852 listed.

4. Fittings for liquidtight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.

5. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.

6. Fittings for electrical metallic tubing shall be interlocking compression type zinc coated steel in dry locations, fittings in damp locations shall have internal sealing ring and knockout gasket.

7. Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.

8. Die-cast or pressure cast fittings are not permitted.

9. Provide conduit bodies types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

10. Acceptable manufacturers:

    a. O.Z. Gedney

    b. Steel City

    c. Thomas & Betts

d. Crouse-Hinds

e. Carlon

H. Expansion Fittings

1. Galvanized steel expansion joints for RGS or EMT conduit, PVC for PVC conduit.

2. Minimum 4” movement in either direction.

3. Weatherproof for outdoor applications.

4. At expansion joints in concrete pours, provide Deflection/Expansion fittings capable of movement of ¾” in all directions from the normal**.**

5. Design Make: O.Z./Gedney, Type "AX" (exposed), “DX” (Concrete Pour)

6. Acceptable manufacturers:

a. O.Z./Gedney

b. Crouse-Hinds

c. Appleton

2.2 SURFACE METALLIC RACEWAY

A. Single channel suitable for up to (9) #12 AWG conductors or (11) 0.2” O.D. Cables

1. Color shall be as selected by architect.

2. Two piece raceway with single compartment, length as indicated on the drawings. Nominal 1-29/32” x 7/8” with snap on cover.

3. Provide tee and corner fittings suitable for cat. 6A and fiber optic bend radius.

4. Design Make: Wiremold V2400 series with “FO” series tees and corners

B. Two channel with devices suitable for up to (48) #12 AWG conductors or (50) 0.2” O.D. Cables.

1. Color shall be as selected by architect.

2. Two piece raceway with divider for power and communications, length as indicated on the drawings. Nominal 4-3/4” x 1-3/4” with 7/16” raised, snap on cover.

3. Provide devices in the raceway as shown on plans

4. Provide tee and corner fittings suitable for cat. 6A and fiber optic bend radius.

5. Seams and placement – CDW _DK

6. Design Make: Wiremold V4000 with "FO" series tees and corners

C. One-piece raceway

1. Color shall be as selected by architect.

2. Size race way as required based on the following:

a. .040" steel suitable for (8) #12 AWG conductors or (2) 0.2" O.D. cables

3. Design Make: Wiremold V700 Series

D. Provide miscellaneous boxes, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.

E. Cat.6A and optical fiber installations:

1. Cable entrance fittings shall include 1" minimum knockouts.

2. Provide 2" minimum radius fittings.

F. Acceptable Manufacturers:

1. Panduit

2. B-Line Systems, Inc.

3. Mono-Systems

2.3 SURFACE NONMETALLIC RACEWAY

A. Two piece construction, manufactured of rigid PVC compound with matte texture with "off-white" finish. Provide the manufacturers standard fittings as required for the installation. All system components shall meet UL 94 requirements for nonflammable, self-extinguishing characteristics.

1. One-Piece Raceway:

a. Hubbell Mini Trak (Design Make)

b. Mono-Systems

c. Panduit

d. Approved Equal

2. Two-Piece Raceways:

a. Provide duplex receptacles or Communication devices as specified in wiring devices and indicated on the drawings.

b. Provide divider in raceways utilized for power and communications.

c. Acceptable manufacturers:

d. Hubbell Base Trak and Wall Trak

e. Mono-Systems

f. Panduit

g. Approved Equal

2.4 WIREWAYS

A. Wireway shall be steel, enclosed type. Provide hinged, JIC sectional NEMA dust resistant, oil tight type where subjected to moisture, in Pump Rooms, Mechanical, Electric and Fan Rooms, exterior walls, Maintenance Shops, and similar locations. Size to meet NEC fill requirements or larger as noted on Contract Documents. Provide knockouts along runs. Provide all elbows, tees, pullboxes, fittings, hangers, reducers, supports, etc., to meet installation requirements.

B. Cover: Hinged Screw cover.

C. Connector: Slip-in Flanged.

D. Fittings: Lay-in type with removable top, bottom, and side; captive screws drip shield.

E. Finish: Electro-coated ASA-49 Gray Epoxy Paint over Phosphate Primer.

F. Acceptable manufacturers:

1. Square D "Square Duct"
2. General Electric
3. Hoffman
4. Keystone/Rees, Inc.

2.5 CABLE HANGERS

A. Provide prefabricated, zinc coated, carbon steel hangers UL listed to support category 5, 6, 6A, optical fiber cable, and innerduct installations.

B. Hangers shall have open top, rolled edges and a 2” diameter loop, J-hook style.

C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.

D. Design Make: Erico CADDY CABLECAT CAT32 series.

PART 3 - EXECUTION

3.1 GENERAL

A. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.

B. Minimum 3/4" trade size for branch circuit and fire alarm wiring.

C. Minimum 3/4" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.

D. Where cable quantities are identified on drawings provide telecom conduit sleeves and raceways according to the below schedule (Note this table is an estimate and the actual quantity is dependent on the installed cable diameter):

| Cat. 5e/6 Cable Qty. | Conduit Trade Size |
|---|---|
| 4 Cables | ¾" Conduit |
| 6 Cables | 1" Conduit |
| 10 Cables | 1 ¼" Conduit |
| 20 Cables | 2" Conduit |
| 70 Cables | 4" Conduit |
| Cat. 6A & RG-6 Cable Qty. | Conduit Trade Size |
| 2 Cables | ¾" Conduit |
| 4 Cables | 1" Conduit |
| 6 Cables | 1 ¼" Conduit |
| 10 Cables | 1 ½" Conduit |
| 20 Cables | 2 ½" Conduit |
| 70 Cables | 4" Conduit |

*Refer to specification section 271000 for maximum outside diameter of Cat.6A cabling.

E. Support raceways from building structure and wall construction. Do not support raceways from ceiling systems ductwork, piping, or equipment hangers. Do not support raceways from pre-existing conduit runs, banks, racks, hangers, etc.

F. Support outlet, pull, and junction boxes independently from building structure and wall construction. Do not support from raceways.

G. Install raceways parallel or perpendicular to building walls, floors and ceilings.

H. Install raceways concealed except in the following areas:

1. Mechanical Rooms
2. Electric Rooms
3. Manufacturing areas
4. Garage or maintenance areas
5. Unfinished basements or crawl spaces

I. Provide a code compliant ground path between all outlets and the established electrical system ground.

J. Cut raceways square, ream ends to remove burrs, and bush where necessary.

K. Coordinate all raceway runs with other trades.

L. Do not install raceways adjacent to hot surfaces or in wet areas.

M. Provide expansion fittings with external grounding straps at building expansion joints.

N. Do not install conduit horizontally in concrete block or dry wall partitions.

O. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.

P. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.

Q. Core drill, sleeve, and fire stop all penetrations through existing floors.

R. Support all raceways with malleable iron pipe clamps or other approved method. In exterior or wet locations, provide minimum ¼" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.

S. Provide conduit seals and explosion proof devices as indicated on the plans and as dictated by the National Electrical Code for all hazardous locations indicated on the drawings.

T. Provide green ground wire in all EMT, flexible conduit, and non-metallic conduit.

U. Do not install voice and data cabling in any surface metal raceway smaller than Wiremold V2400, except single voice outlets where cable runs straight down and no bends occur in raceway.

V. All accessible raceways, boxes and enclosures (including transfer switches, generators and power panels) for emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system. Accessible raceways shall be marked at least once every 3 m (10 ft). Acceptable means of marking shall include, but is not limited to, a permanently affixed identification nameplate, yellow in color with black lettering.

3.2 CONDUIT

A. Install with a minimum of bends and offsets. Bends shall not kink or destroying the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.

B. Provide at least one junction or pullbox for each 270 degrees of bends.

C. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.

D. Provide U.L. approved rain-tight and concrete-tight couplings and connectors.

E. Secure within three feet of each outlet box, junction box, cabinet or fitting.

F. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.

G. Install raceways in concrete floor slabs as follows:

1. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings.

2. Provide expansion fittings where conduits cross building expansion joints.

3. Install conduit below the reinforcing mesh.

4. Locate conduits to provide a minimum of 1” of concrete around conduit.

5. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.

H. Wherever a cluster of four (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.

I. Provide conduit supports based on the following table:

| Conduit Trade Size | Type of Run | Horizontal Spacing in Feet | Vertical Spacing in Feet |
|---|---|---|---|
| ½” , 3/4" | Concealed | 7 | 10 |
| 1”,, 1-1/4" | Concealed | 8 | 10 |
| 1-1/2” & larger | Concealed | 10 | 10 |
| ½”, 3/4" | Exposed | 5 | 7 |
| 1”, 1-1/4" | Exposed | 7 | 8 |
| 1-1/2” & larger | Exposed | 10 | 10 |

J. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.

K. Provide 4 spare 3/4-in. raceways from each flush mounted panelboard or cabinet to an area above the nearest accessible ceiling space. Make 90$^{o}$ turn above the ceiling, arranged for further continuation of raceway, and cap.

L. Flexible tubing shall have a limit of 6’-0” in length from outlet box and or disconnecting means to vibrating equipment and/or lighting fixtures only

M. Conduit System Installation:

1. Wiring above 600 volts in indoor or exterior, above grade locations:

    a. Rigid Galvanized Steel

2. Wiring below 600 volts, interior locations:

    a. Electrical Metallic Tubing

    b. Rigid Galvanized Steel in mechanical rooms, electrical rooms, garages, maintenance areas, and manufacturing areas.

3. Wiring below 600 volts, exterior, above grade locations and hazardous locations:

    a. Rigid Galvanized Steel

4. Wiring below 600 volts, exterior, above grade locations and hazardous locations:

    a. Rigid Galvanized Steel

    b. PVC Coated

    c. Seal-tight Flexible Conduit (connection whips only)

5. Wiring below 600 volts, interior, inside Swimming Pool and Pool mechanical room locations:

    a. Rigid Galvanized Steel

    b. Seal-tight Flexible Conduit (connection whips only)

3.3 SURFACE RACEWAYS

A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.

B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.

C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.

D. Submit factory drawings detailing the installation. Include a complete part list.

END OF SECTION 260533

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Receptacles

2. Coverplates

1.3 QUALITY ASSURANCE

A. All wiring devices shall be installed neatly, and parallel with building lines. Recessed devices shall be flush with the face of the wall. Provide extension rings on outlet boxes as required. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.4 SUBMITTALS

A. Provide product data for all wiring devices and cover plates.

PART 2 - PRODUCTS

2.1 GENERAL

A. Wiring devices shall be specification grade as a minimum.

B. Wiring device color shall be as selected by architect.

C. Suitable for installation in a 2-1/2” deep outlet box.

D. All receptacles and switches shall be from the same manufacturer.

E. Acceptable Manufacturers:

1. Hubbell
2. Pass & Seymour/Legrand
3. Arrow Hart
4. Eaton
5. Bryant

6. Leviton

2.2 CONVENIENCE DUPLEX RECEPTACLES

A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

B. Side and back wiring.

C. 0.32" thick brass three prong power contacts and #8 brass screws

D. Brass center rivet

E. All brass grounding system

F. Nylon face with glass reinforced nylon back

G. Dielectric Voltage withstands 2,000V minimum

H. Terminals Identified in accordance with UL 498

I. Tamper-Resistant

J. UL 94V-2 Flame rating

2.3 USB CHARGING RECEPTACLES

A. Décor Style

B. Commercial Grade USB Charger Outlet: (1) *Type-C* port and one (1) Type-A port configuration, high power 5 Amp, 5 Volt USB output, Tamper-Resistant duplex receptacle, USB ports rated 10,000 cycles.

C. Duplex 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

D. LED indicator lamp to show *USB2.0* power is available.

E. Tamper Resistant

F. Meets UL94 and complies with USB BC1.2

G. Red in color.- for branch circuits on critical system, life safety system and standby system

2.4 GFI RECEPTACLES

A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

B. LED trip/test indication

C. Tamper Resistant

D. Side and back wiring.

E. Nylon face and back.

F. 2006 UL 943 revisions including “no power to the face when miswired” and “end of life indication” when unit is no longer capable of providing GFI protection

G. Designed to trip at maximum 6mA leakage current to ground.

H. Suitable for feed through protection.

2.5 CONTROLLED RECEPTACLES

A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

B. Side and back wiring.

C. 0.32” thick brass three prong power contacts and #8 brass screws

D. Brass center rivet

E. All brass grounding system

F. Nylon face with glass reinforced nylon back

G. Dielectric Voltage withstands 2,000V minimum

H. NFPA 70 – NEC – 406.3(E) Controlled receptacle marking on device.

I. Single or dual receptacles controlled – refer to drawings.

J. Terminals Identified in accordance with UL 498

K. Tamper-Resistant

L. UL 94V-2 Flame rating

2.6 COVERPLATES

A. Provide type 302 stainless steel cover plates with satin finish for general purpose flush devices.

B. Provide utility cover plates for surface mounted devices in mechanical rooms.

C. Provide gasketed cover plates with a hinged cover on a cast aluminum outlet box for all devices in wet areas designated “WP”.

2.7 WEATHERPROOF COVERS

A. Impact resistant polycarbonate, NEMA 3R construction.

B. Clear cover to view the connection of the device.

C. UL listed as a weatherproof enclosure with the receptacle in use.

D. Hinged, latching cover with an opening at the bottom for a cord to exit the device.

E. Padlockable

F. Suitable for installation of a GFI protected duplex receptacle.

G. Design Make: Hubbell Catalog No. WP26MGP

H. Acceptable Manufacturers:

1. Hubbell
2. Leviton
3. Arrow Hart
4. Pass & Seymour
5. Bryant

PART 3 - EXECUTION

3.1 GENERAL

A. Install devices generally where called for.

B. Coordinate exact locations of all devices with equipment, millwork, counters, fin radiation, windows, etc. and adjust locations as required as part of this contract.

C. Provide steel box for all devices.

D. Install receptacles and switches vertical, with the grounding pin down, and the toggle up in the on position.

E. Install all switches on the strike side of the door, with the edge of the outlet box approximately 3" from the door frame.

F. Do not install devices "back to back" in the same stud cavity without prior approval of the Owner. Offset devices as required to maintain code required fire rated assemblies or provide fire-stopping assembly around adjacent devices.

G. Provide plaster rings on all outlet boxes to permit flush installation of devices.

H. In all wet or damp areas, provide a surface mounted cast aluminum outlet box with threaded connections, gasketed cover, and non-ferrous screws.

I. Prior to installation and as part of the contract, relocate any device a distance of 5 feet in any direction at the request of the Owner.

J. Size outlet boxes in accordance with the NEC, based on the number and size of wires in the box.

K. Provide a coverplate on all devices.

3.2 LABELING

A. Provide tape labels indicating panelboard and circuit on the outside of all device coverplates.

B. Edit per a Campus standard

3.3 SPARE WIRING DEVICES

A. Furnish stock of 10% but not less than (4) of the following devices

1. List Devices Here.

3.4 TESTING

A. Test all receptacles for proper voltage, polarity, and grounding.

B. Test all GFI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.

C. Rewire receptacles as required until receptacles test properly.

END OF SECTION 260620

SECTION 262400 - SWITCHBOARDS AND PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Circuit Breakers
2. Branch Circuit Panelboards
3. Enclosed Circuit Breakers

1.3 RELATED SECTIONS

A. 260573 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

1.4 QUALITY ASSURANCE

A. All low voltage power distribution equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and installation practices specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)

a. 240 - Overcurrent Protection
b. 368 - Busways
c. 404 - Switches
d. 408 - Switchboards and Panelboards

2. The following National Electrical Manufacturers Association (NEMA) Standards:

a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case

Switches
b. NEMA BU 1 - Busways
c. NEMA PB 1 - Panelboards
d. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
e. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
f. NEMA 250 - Enclosures for Electrical Equipment

3. The following American National Standards Institute (ANSI) standards:

a. ANSI/NETA-2013 ATS for Electrical Power Equipment and Systems
b. ANSI/IEEE C12.1 Code for Electric Metering

4. The following U.L. Standards:

a. UL 50 - Enclosures for Electrical Equipment
b. UL 67 - Panelboards
c. UL 98 - Enclosed and Dead-Front Switches
d. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures
e. UL 857 - Underwriters Busway Standard
f. UL 891 – Standard for Switchboards
g. UL 943 - Standard for Ground Fault Circuit Interrupters
h. UL 1449 – Surge Protective Devices

## 1.5 SUBMITTALS

A. Provide results of power system evaluation with submitted short circuit and overcurrent protective device study.

B. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:

1. Thermal Magnetic Molded Case Circuit Breakers
2. Electronic Trip Molded Case Circuit Breakers
3. Electronic Trip Insulated Case Circuit Breakers
4. Load Centers
5. Branch Circuit Panelboards
6. Distribution Panelboards
7. Field Supervisor
8. Switchboards, including the following:

a. Dimensioned plans and elevations.
b. Internal and External Connection Diagrams.
c. Power and control wiring diagrams.
d. Bill of Materials
e. Any modifications made to the switchboard or distribution system design to accommodate manufacturer's standard equipment.
f. Where utility equipment is required in the switchboard, show required modifications to the switchboard, and submit drawings reviewed and

approved by the utility company.

9. Surge Protective Devices
10. Service Entrance Power Monitor
11. Bus Ducts
12. Enclosed Circuit Breakers

1.6 MAINTENANCE MATERIALS

A. Furnish to owner spare parts for maintenance needs include the following:

1. Two spare keys for each cabinet lock.
2. Circuit breakers two spare breakers for each type.
3. Two adjustable trip settings devices for each frame size provided. Coordinate with overcurrent protective device study.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS

A. General

1. UL 489 listed.
2. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.
3. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.
4. Provide multi-pole breakers with common trip.
5. When the circuit breaker has tripped, the handle shall move to a position between the “on” and “off” positions. Provide a visual indication that the circuit breaker has tripped.
6. The ampere rating shall be clearly marked on the face of the circuit breaker.
7. Series rated fuse/circuit breaker installations are not acceptable.
8. Make provisions to add circuit breaker handle locks.
9. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.
10. New circuit breakers installed in existing panelboards shall be UL listed for use in panelboard.

B. Thermal Magnetic Molded Case Branch Circuit Breakers

1. Below 250Amps – Unless otherwise noted operation shall be fixed thermal magnetic trip unit. Permanent trip unit containing individual thermal and magnetic trip elements.

2. 250Amps and above - Include field adjustable electronic Long Time, Short Time, and Instantaneous trip unit.
3. 400Amps and above - Include field installed interchangeable rating plugs.
4. 75°C terminal temperature rating for circuit breakers
5. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.
6. Circuit breakers shall be bolt-on. Plug-on acceptable in load centers on residential applications only.
7. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.
8. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero sequence sensing ground fault module.
9. Design Make: Square D QOB (250 volt), EH, EHB (480 volt), I-Line style (600 volt).
10. Acceptable Manufacturers:

    a. Square D
    b. Eaton
    c. General Electric
    d. Siemens

C. Standard Function Electronic Trip Molded Case Circuit Breakers

1. Microprocessor based true RMS sensing current sensing device with accuracy to the thirteenth harmonic.
2. Sensor frame and rating plug size shall be as indicated on the Panelboard Schedule.
3. UL listed to carry 80% of the ampere rating continuously.
4. Provide the following time/current response adjustments:

    a. Long Time Pickup
    b. Long Time Delay
    c. Short Time Pickup
    d. Short Time Delay (I2t IN only)
    e. Instantaneous Pickup
    f. Ground Fault Pickup
    g. Ground Fault Delay (I2t OUT only)

5. Provide a means to cover the trip unit adjustments in accordance with NEC Article 240-6(b).
6. Provide trip indication for overload, short circuit, and ground fault trips.
7. Tripping system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing.
8. Design Make: Square D LX, MX, NX, PX
9. Acceptable Manufacturers:

    a. Square D
    b. Eaton
    c. General Electric

d. Siemens

D. Full Function Electronic Trip Molded Case Circuit Breakers

1. Microprocessor based true RMS sensing current sensing device with accuracy to the thirteenth harmonic.
2. Sensor frame and rating plug size shall be as indicated on the Panelboard Schedule.
3. UL listed to carry 100% of the ampere rating continuously.
4. Provide the following time/current response adjustments:

    a. Long Time Pickup
    b. Long Time Delay
    c. Short Time Pickup
    d. Short Time Delay (I2t IN and I2t OUT)
    e. Instantaneous Pickup
    f. Ground Fault Alarm only Pickup
    g. Ground Fault Pickup
    h. Ground Fault Delay (I2t IN and I2t OUT)

5. Provide a means to cover the trip unit adjustments in accordance with NEC Article 240-6(b).
6. Provide trip indication for overload, short circuit, and ground fault trips.
7. Capable of being monitored remotely for circuit breaker status, phase and ground fault currents, switch settings, and trip history.
8. Tripping system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing.
9. Design Make: Square D LE, ME, NE, PE
10. Acceptable Manufacturers:

    a. Square D
    b. Eaton
    c. General Electric
    d. Siemens

E. Full Function Electronic Trip Insulated Case Circuit Breakers

1. Microprocessor based true RMS sensing current sensing device with accuracy to the thirteenth harmonic.
2. Sensor frame and rating plug size shall be as indicated on the Panelboard Schedule.
3. UL listed to carry 100% of the ampere rating continuously.
4. Provide the following time/current response adjustments:

    a. Long Time Pickup
    b. Long Time Delay
    c. Short Time Pickup

d. Short Time Delay (I2t IN and I2t OUT
e. Instantaneous Pickup
f. Ground Fault Pickup
g. Ground Fault Delay (I2t IN and I2t OUT)

5. Provide a means to cover the trip unit adjustments in accordance with NEC Article 240-6(b).
6. Provide trip indication for overload, short circuit, and ground fault trips.
7. Capable of being monitored remotely for circuit breaker status, phase and ground fault currents, switch settings, and trip history.
8. Tripping system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing.
9. Stored energy mechanism with 5 cycle closing time to open and close the circuit breaker.
10. Local pushbutton operation to open and close the circuit breaker.
11. Visual indication of the stored energy mechanism being "charged" or "discharged".
12. Electrical operation to open, close, or charge the circuit breaker.
13. Design Make: Square D SE
14. Acceptable Manufacturers:

a. Square D
b. Eaton
c. General Electric
d. Siemens

2.2 BRANCH CIRCUIT PANELBOARDS

A. 240 Volt rated, maximum 400 amperes.

B. Copper bus bars with high dielectric thermoplastic insulators.

C. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.

D. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.

E. Service entrance rated where required and or noted on plans.

F. Convertible mains from top to bottom feed.

G. Provide ground and neutral busses of the same material as the main bus.

H. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.

I. Enclosures shall be nominal 20" wide by 6" deep, galvanized steel construction with removable endwalls and knockouts.

J. Fronts

1. Surface or flush mounted as called for on the Panelboard Schedule.
2. ANSI 49 gray electrodeposited enamel.
3. Fronts shall be one piece with door, and continuous hinge to the enclosure.
4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike to match existing panelboards.
5. Provide a clear plastic directory card holder on the inside of the door.

K. Accessories

1. Provide Isolated ground bus adequate for branch isolated ground conductors.
2. Feed-thru lugs, compression type lugs installed at the opposite end of incoming lugs or main device.
3. Subfeed Lugs - compression type lugs installed at the same end of bus as incoming lugs or main device.
4. Surge Protection devices. Minimum rating of single pulse surge 100kA. Protection modes, 1200V line to line(surge devices are all required on all panelboards installed on life safety branch panel served from a generator)

L. Design Make: Square D NQ Series

M. Acceptable Equivalents:

1. Eaton Pow-R-Line Series
2. General Electric A-Series
3. Siemens P1 Panelboard Series

2.3 ENCLOSED CIRCUIT BREAKERS

A. Circuit breakers shall be as specified above.

B. Ratings as indicated on plans and as required by the installation.

C. Short Circuit Withstand ratings of the assembly shall be equal to that of the circuit breaker.

D. Provide NEMA rated enclosure as called for on the drawings, and as required by the environment.

E. Externally operable handle, with provisions for padlocking in the OFF and On position.

F. Gray baked enamel finish except for stainless steel, NEMA 4X enclosures.

G. Knockouts at the top and bottom of NEMA 1 enclosures.

H. Design Make: Square D

I. Acceptable Manufacturers:

1. Square D
2. Eaton
3. General Electric
4. Siemens

PART 3 - EXECUTION

3.1 GENERAL

A. Provide identification for all equipment and devices as indicated in section 260100 Basic Materials and Methods.

B. Mount surface mounted panelboards on steel slotted supports, orient steel slotted supports vertically,

C. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.

D. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to frounding electrodes and ground bars.

E. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items ad required.

F. Ensure minimum NEC working clearance for all equipment.

G. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.

H. Provide testing in accordance with ANSI/NETA-2013 ATS for Electrical Power Equipment and Systems. Correct malfunctioning device on site, when possible. Re-test to demonstrate compliance.

I. Modify settings breaker and relay settings to meet the requirements of the overcurrent protection study,

J. Provide identification as required per section 260100 Basic Materials and Methods.

K. Contractor shall be responsible to applying all trip settings and adjust installed breakers prior to energizing the electrical systems. Per approved overcurrent protection study.

1. Perform the following infrared scan test and prepare reports;After substantial completion perform infrared scanning of each switchboard and panelboard. Remove front panels so all connections are accessible to the scanner.
2. Use infrared scanner to measure temperature or detect significant deviations from normal values.
3. Provide written report of all scan, include normal and deviations along woth calibration record of device.

L. After substantial completion, measure loads to balance phases;

1. Measure loads during a period of normal operations.
2. Perform circuit changes to achieve load balancing after normal hours, coordinate allowable times with project architect.

M. After changing circuits to achieve loads balancing recheck loads during normal operation hours. Record loads before and after. Phase differences may not exceed 15%. Update panel schedules after all testing and load balancing has been completed.

N. Provide covers for all openings. Covers shall be UL listed for useapplications. Do not use dissimilar metals inapplication.

## 3.2 CIRCUIT BREAKERS

A. Install circuit breakers in panelboards and switchboards as called for on the plans and as recommended by the manufacturer.

B. Submit documentation that a qualified representative from the equipment manufacturer has inspected and approved the installation.

## 3.3 BRANCH CIRCUIT PANELBOARDS

A. Install panelboards with top of the highest circuit breaker handle at 6’-6” to the centerline.

B. Provide (5) five empty ¾” conduits and (1) one empty 1 ½” conduit from each flush mounted panelboard backbox to the accessible ceiling space. Make 90$^{o}$ turn above the ceiling, arranged for further continuation of raceway, and cap.

C. Make all branch circuit and feeder connections.

D. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.

E. Measure steady state load currents on each panelboard feeder. Rearrange branch circuits in the panelboard to balance the load within 20% of each other. Maintain proper phasing.

3.4 ENCLOSED CIRCUIT BREAKERS

A. Install enclosed circuit breakers in locations shown on plans. Install true and level.

B. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.

END OF SECTION 262400

SECTION 262455 - CIRCUIT BREAKERS FOR EXISTING PANELBOARDS

PART 1 GENERAL

1.1 SUBMITTALS

A. Not required.

PART 2 PRODUCTS

2.1 CIRCUIT BREAKERS

A. UL listed and labeled for use with existing panelboard, breakers to match AIC rating of existing breakers.

B. Number of poles and ampere trip rating as indicated on drawings.

C. Complete with accessories required for installation, including but not limited to mounting kits and bus extensions.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install new circuit breakers in existing panelboards where indicated.

B. Add new circuits equally across phases to prevent overloading any phase in the panelboard. After new and existing circuits are energized, take current reading on panelboard feeder during a heavy usage time period. If phases are 20% or more unbalanced, rearrange both new and existing circuits in panelboard to equally distribute load between all phases, and provide new typewritten directory indicating equipment controlled by each circuit breaker.

END OF SECTION 262455

SECTION 262913 - SWITCHES, CONTACTORS AND MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Safety Switches (Disconnect)

2. Lighting Contactors

3. Motor Control Equipment

4. Low Voltage Fuses

1.3 QUALITY ASSURANCE

A. All low voltage power distribution equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and installation practices specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)

a. 240 - Overcurrent Protection

b. 404 – Switches

c. 430 – Motors, Motor Circuits, and Motor Controllers

2. The following National Electrical Manufacturers Association (NEMA) Standards:

a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches

b. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.

c. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

d. NEMA 250 - Enclosures for Electrical Equipment

3. The following American National Standards Institute (ANSI) standards:

a. ANSI/IEEE C12.1 Code for Electric Metering

4. The following U.L. Standards:

a. UL 50 - Enclosures for Electrical Equipment

b. UL 98 - Enclosed and Dead-Front Switches

1.4 SUBMITTALS

A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:

1. Safety Switch (Disconnect)

2. Lighting Contactors

3. Motor Control Equipment

4. Low Voltage Fuses

1.5 MAINTENANCE MATERIALS

A. Provide extra maintenance materials for repairing for devices indicated in this specification.

1. Fuses – ten percent of each quantity, with a minimum of three.

2. Indicating lights - two light assemblies for each color type.

3. Power contacts - furnish three spares for each type of contactor installed.

1.6 MINOR MODIFICATIONS

A. Provide modifications to fuse sizes within the frame size at no additional cost

B. Fuse adapters – provide fuse reducers as required to allow for fuses to operate in fused safety switch.

1.7 FIELD SUPERVISION

A. Provide field supervision and start-up by a qualified representative of the equipment

manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 SAFETY SWITCHES (DISCONNECT)

A. Three pole, single throw, or as called for on the drawings.

B. Quick-make, quick-break switch operating mechanism.

C. Heavy-duty, current rating as called for on the drawings, voltage rating as required by the equipment served.

D. All current carrying parts shall be plated to resist corrosion.

E. Lugs shall be removable and rated for 75°C temperature rating.

F. Switch blades shall be visible when the switch is in the open position and the door is open.

G. Switch shall be padlockable in the OFF and ON positions.

H. Fusible switches to be furnished with rejection type fuse holders and fuses as indicated on the plans or as per fed equipment requirements.

I. Provisions for a field installable electrical interlock contacts on disconnect handle.

J. Provide external override mechanism to open the disconnect switch door without opening the disconnect switch.

K. Optional equipment

1. Neutral Lugs

2. Ground lugs

3. Auxiliary contacts, form C contacts arranged to operate prior to switch opening. NO/NC rated at 240V ac

L. Enclosure shall be steel with gray baked enamel paint.

M. Provide NEMA type enclosures as called for on the drawings.

N. NEMA type 1 enclosures shall be equipped with knockouts.

O. Design Make: Square D

P. Acceptable Manufacturers:

1. General Electric

2. Cutler Hammer

3. Siemens ITE

2.2 SHUNT TRIP SWITCHES

A. Heavy duty, Three pole, single throw, Comply with ASME A17.1, UL 50 and UL 98 with class J fuse block. Integral shunt trip mechanism,

B. Control circuit 120V ac shall be obtained from integral control power transformer with primary and secondary fuses.

C. All current carrying parts shall be plated to resist corrosion.

D. Lugs shall be removable and rated for 75°C temperature rating.

E. Accessories shall be furnished with the switch, including;

1. Keyed switch for testing function
2. Green indicating pilot light – On
3. Mechanically interlocked auxiliary contacts.
4. Three pole double throw fire safety and alarm relay, coil voltage 120V ac or 24V dc.
5. Three pole, double pole fire alarm monitor relay, complying with NFPA 72.
6. Form C Alarm contacts – indicating tripped switch.
7. Auxilary contact kit – two NO/NC form C rated at 240V

F. Switch blades shall be visible when the switch is in the open position and the door is open.

G. Switch shall be padlockable in the OFF and ON positions.

2.3 MOTOR CONTROL EQUIPMENT

A. General

1. Provide motor starters, disconnect switches, etc., as listed on the Electric Equipment and Control Schedule on the drawings.

2. Starters, contactors and controllers shall comply with NEMA standards having general purpose NEMA 1 or 1B enclosure unless otherwise called for. Provide explosion proof, weather resistant or watertight construction as required. Starters

shall be minimum NEMA size 0 with overloads in each phase sized per NEC, nameplate motor full load amperage, service factor, and motor operating conditions.

3. Magnetic Contactor Ratings

| NEMA SIZE | CONTINUOUS AMP RATING | HP 230 VAC | HP 460 VAC |
|---|---|---|---|
| 00 | 9 | 1 | 2 |
| 0 | 18 | 3 | 5 |
| 1 | 27 | 5 | 10 |
| 2 | 45 | 15 | 25 |
| 3 | 90 | 30 | 50 |
| 4 | 135 | 50 | 100 |
| 5 | 270 | 100 | 200 |
| 6 | 540 | 200 | 400 |
| 7 | 810 | 300 | 600 |
| 8 | 1215 | 150 | 900 |
| 9 | 2250 | 800 | 1800 |

4. Pad lock arrangements shall be provided to lock the disconnect device in the "off" position. Magnetic starters shall be provided with a control power transformer with 120V secondary and primary and secondary fusing and be sized to accept the loads imposed there on. Starters shall have transformer type pilot lights and 6 volt long life bulbs. Each starter subject to electrical interlock and/or automatic control shall have necessary auxiliary contacts.

5. Auxiliary devices: Provide pushbutton stations, pilot lights, devices, relays, transformers, selector switches, electric thermostats, auxiliary starter contacts as required for functions called for. Provide separate relay for each speed to operate electric dampers or other devices as required for multispeed motor circuit.

6. Manual Motor Starter: Provide all starters with thermal overload(s); and pilot light(s), and handle lock-out provisions. Gang starter with selector switch for multispeed applications. Provide single or 2-pole as required:

a. 120 volt, single-pole, surface mounted: Square-D FG-1P.

b. 120 volt, single-pole, flush mounted: Square-D FS-1P.

c. 120 volt, single-pole, two speed, surface mounted: Square-D FG-11P.

d. 120 volt, single-pole, two speed, flush mounted: Square-D FS-101P.

e. 120 volt, single-pole, H-O-A selector, surface mounted: Square-D FG-72P.

f. 120 volt, single-pole, H-O-A selector, flush mounted: Square-D FS-72P.

g. Manual Motor Starter - Speed Controller: Shall be similar to "Manual Motor Starter", above, except two-gang with motor speed control sized to handle motor indicated, with positive full on and full off bypass of speed control unit.

7. Manual Starter with Relay: Shall be similar to "Manual Motor Starter", above, except two-gang with relay sized for load indicated, and hand-off-automatic switch. Connect relay for 120V operation on load side of starter in "automatic" mode. Coordinate connection of Form C maintained contact for control with Mechanical Contractor.

B. Magnetic Starters

1. Shall be single-speed, across-the-line type rated in accordance with NEMA standards, sizes and horsepower ratings.

2. Starters shall be mounted in NEMA 1 enclosures unless otherwise indicated.

3. Magnetic starters shall be equipped with double break silver alloy contacts; all contacts shall be replaceable without removing starter or disconnecting power wiring.

4. Starter shall have straight-through wiring. Coils shall be of molded construction and shall be replaceable from the front without removing starter.

5. Overload relays shall be melting alloy type with replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.

6. Overload relay shall be solid state type with dial slectable for overload protection. Each phase to have a sensor allowing for protection against voltage and current imbalance, single phasing, and include class II ground fault protection.

7. Provide hand-off-auto selector switch**,** start-stop pushbuttons and "run" pilot light

in cover. Wire for maintained contact unless otherwise noted.

C. Combination Magnetic Starter: Shall be similar to "Magnetic Starter", above, except shall include fusible circuit breaker disconnect switch connected ahead of starter. The disconnect handle shall be in control of the disconnect device with the door open or closed. Disconnect handle shall be clearly marked as to whether the disconnect device is "on" or "off".

D. Combination Two-Speed Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except with two starters, and six thermal overload units coordinated to match torque and horsepower characteristics of the motor. Starter shall be designed for variable torque operation, and shall be provided with high-low-off-auto selector switch and high and low pilot lights mounted in the cover. Wire for maintained contact unless otherwise noted.

E. Combination Reduced Voltage Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except auto-transformer closed transition reduced voltage type with auto-transformer protection by winding over-temperature device.

F. Packaged Control Unit: Shall be furnished under Division 22 or 23, and connected by Electrical Contractor. Generally consists of one or more starters, disconnect switches and additional control devices prewired.

G. Contactor: Shall be similar to "Magnetic Starter", above, except without thermal overload units.

H. Duplex Motor Controller

1. General Operation

a. Controller consists of two starters in a common enclosure with separate fused disconnect switches for each starter.

b. An integral alternation circuit shall be provided which alternately operates first one motor and then the other on each successive closing of an external control device.

c. If one motor is running and its associated disconnect is opened, an overload relay trips or the starter is de-energized for any reason; the other motor will automatically be started.

2. Magnetic starters shall be single-speed; across-the-line type rated in accordance with NEMA standards, sizes and horsepower ratings.

3. Magnetic starters shall be mounted in NEMA 1 enclosures unless otherwise indicated.

4. Magnetic starters shall be equipped with double break silver alloy contacts; all contacts shall be replaceable without removing starter or disconnecting power wiring.

5. Overload relays shall be melting alloy type with replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.

6. Overload relay shall be solid state type with dial slectable for overload protection. Each phase to have a sensor allowing for protection against voltage and current imbalance, single phasing, and include class II ground fault protection.

7. Provide hand-off-auto selector switch**,** start-stop pushbuttons and "run" pilot light in cover for each motor. Wire for maintained contact unless otherwise noted.

8. Provide one fused control circuit transformer.

9. Controller shall be prewired with a terminal block for connection of external control devices.

I. Acceptable manufacturers:

1. Square D

2. Siemens

3. General Electric

4. Eaton

2.4 LIGHTING CONTACTORS

A. 480V rated contacts, minimum of 30A or larger rating as called for on the drawings.

B. Electrically operated, electrically held

C. Provide with 120V coil

D. Provide with NEMA 1 enclosure or enclosure type if specified otherwise on drawings.

E. Provide with number of poles as called for on the drawings

F. Shall be field convertible for NO/NC operation

G. Design Make: Square D Class 8903

H. Acceptable manufacturers:

1. Siemens

2. General Electric

3. Eaton

2.5 LOW VOLTAGE FUSES

A. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide one complete sets of fuses for all fusible disconnect switches, plus 3 spare fuses of each size.

B. Acceptable manufacturers: Fuses 600 amperes and below: Bussman Type FRN-R (300 volts), Type FRS-R (600 volts) or Approved Equal.

C. Add some meat to this section

PART 3 - EXECUTION

3.1 GENERAL

A. Provide identification for all equipment and devices as indicated in section 260100.

B. After installation clean equipment, and inspection for proper installation, including anchored properly and aligned and proper maintenance space.

C. Verify proper operation of equipment including alignment of blades/contacts, fuse sizes and adequate mechanical support/contact integrity.

D. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.

E. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items as required.

F. Provide minimum NEC working clearance for all equipment.

G. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provides replacement lug or in line splice as directed by Owner's Representative.

H. Location of Equipment within line of sight, and in compliance with NEC section 110.29

I. NEMA types and where used in a building Pull all reference to NEMA from above and have use table below.

J. Provide identification as required per Section 260100 Basic Materials and Methods.

3.2 SAFETY SWITCHES – (DISCONNECT)

A. Tighten all bolt and lug connections using a torque wrench or screwdriver per the

manufacturer's recommendations.

B. Provide identification as required per Section 260100.

C. Provide fuses and required accessories in all fusible switches.

D. Provide Electrical test as follows:

1. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

2. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

3. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

4. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

## 3.3 LOW VOLTAGE FUSES

A. Install low voltage fuses in equipment as called for on the plans.

B. Turn all spare fuses over to the Owner and obtain receipt.

C. Examine holders to receive fuses for compliance with installation requirements.

D. Examine equipment name plate and installation instructions, Install fuses of sizes and characteristics appropriate for each piece of equipment.

## 3.4 MOTOR CONTROL EQUIPMENT

A. Provide overload and fuses. Coordinate sizes with division 22 or 23 contractor.

B. Terminate control wiring. Coordinate with division 22 or 23 contractor.

C. Tighten all bolt and lug connections using a torque wrench or screwdriver per the

manufacturer’s recommendations.

D.

E. Prior to releasing the starter and disconnect order the division 26 contractor shall obtain verification in writing from the division 22 and 23 contractors that all starter and disconnect sizes and types are correct. The division 26 contractor shall bear all cost if written approval is not obtained prior to releasing the order and size changes are required.

F. Provide electrical test as follows:

1. insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.

2. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

3. Test motor protection devices according to manufacturer's published data.

END OF SECTION 262913

SECTION 265100 – LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide complete installation, including luminaires, standards, hangers, supports, fittings, lamps, wiring, connections and controls, as indicated in the Contract Documents. Types of luminaires in this project include LED only.

B. Provide Lighting System Functional Testing as described in this section by a factory authorized manufacturer's representative hereby referred to as the Testing Agent.

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. LED Luminaires
2. LED Drivers
3. Emergency and Exit Luminaires
4. Emergency Switching Module
5. Startup and Testing

1.3 SUBMITTALS

A. Submit shop drawings as described in Section 260010. Shop drawings shall include photometric data for each luminaire utilizing the specified lens/louver type, lamp(s) and driver(s). All luminaire types and lighting control system components shall be submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab.

1. Information on each luminaire shall include:

a. Manufacturer and Catalog Number.

b. Dimensioned Construction Drawing(s).

c. Standard Catalog "Cut" Sheet.

d. Photometrics.

e. Lens/Louver Type.

f. Driver Type and Rating.

g. Maintenance Data

2. Emergency Switching Modules

1.4 QUALITY ASSURANCE

A. Luminaires shall be standard products of manufacturers regularly engaged in the manufacture of the specific type luminaires specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the luminaires shall have a minimum of five (5) years of successful installation experience on projects with interior lighting work similar to the requirements of this project.

B. Codes and Standards

1. NEC:

a. Shall comply with Articles 220, 410 and 510 as applicable to installation and construction.

2. NEMA:

a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.

3. UL:

a. All interior lighting luminaires and components shall be UL listed and labeled.

b. Comply with all applicable UL standards including UL 486A and B.

4. All work shall comply with applicable local code requirements of the authority having jurisdiction.

C. Verify the availability of all luminaires proposed to be used in the execution of the work prior to submitting for approval. The discontinuance of production of any luminaire after such approval has been granted shall not relieve the Contractor from furnishing an approved luminaire of comparable quality and design at no additional cost.

D. Luminaires shall be as specified in the "Luminaire Schedule." Luminaire types, characteristics, photometrics, finishes, etc., correspond to the first manufacturer, and associated catalog number, listed in the "Luminaire Schedule." Provide a sample luminaire from the factory for any products not listed as acceptable for approval. The Engineer reserves the right to disapprove any luminaire type submitted which is not equal in quality, appearance or performance to the luminaire specified.

E. All luminaires shall meet the Total Luminaire Efficiency (TLE) requirements of the New York State Energy Conservation Construction Code.

PART 2 - PRODUCTS

2.1 LED LUMINAIRES

A. General:

1. Manufacturers shall be a registered with the Department of Energy (DOE) as a Quality Advocate and taken the pledge to be listed on the LED lighting facts website.

2. Luminaire measurements have been standardized and are in compliance with IESNA Standard LM-79 test procedure.

3. LED's have been standardized and are in compliance with IESNA Standard LM-80 and demonstrate L70 life after 50,000 hours.

4. Luminaires and/or replacement lamps shall be either Energy Star certified or Design Lights Consortium listed where noted on the luminaire schedule to qualify for NYSERDA or Utility provider rebate incentives. Submitted luminaires not currently on the DLC qualified products list (http://www.designlights.org/) will be rejected.

5. Manufacturers shall prove color consistency across all LED's via 3 step MacAdam Ellipse.

6. Luminaires shall be tested at an ambient temperature of +25 degrees for a minimum of 6000hrs.

7. Maximum junction temperature of 80°C.

8. Minimum drive current of 350mA. Maximum drive current of 700mA.

9. Luminaires shall have a minimum 5 year warranty.

10. Refer to Luminaire Schedule on drawings for complete Luminaire makes and models.

2.2 LED DRIVERS

A. Dimmable Drive (Fade to Black 1%)

1. Driver shall be of the constant current type.

a. Voltage: 120/277 as noted on drawing

b. Driver Current: 350mA – 700mA.

c. 0-10v dimming capable down to 10%.

d. Maximum THD: 10%

e. UL Listed Class P

2. Acceptable Manufacturers:

1) eldoLED

2) Philips Advance - Xitanium

3) Lutron Hi-Lume

4) Sylvania/Osram - Optotronic

B. Dimmable Driver (0-10v):

1. Driver shall be of the constant current type.

a. Voltage: 120/277 as noted on drawing

b. Driver Current: 350mA – 700mA.

c. 0-10v dimming capable down to 10%.

d. Maximum THD: 10%

e. Minimum Power Factor: 0.9

f. Acceptable Manufacturers

1) eldoLED

2) Philips Advance - Xitanium

3) Lutron Hi-Lume

4) Sylvania/Osram - Optotronic

2.

2.3 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61.

G. Bulb Shape: Complying with ANSI C79.1.

2.4 EMERGENCY LIGHTING

A. Emergency Luminaires:
1. Emergency Luminaires: as indicated on Drawings, with the following additional features:
2. Operating at universal nominal voltage
3. Internal emergency power unit.
4. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
5. UL 94 5VA flame rating.

B. Emergency Lighting Unit:
1. Emergency Lighting Unit: as indicated on Drawings.
2. Operating at universal voltage.
3. Wall with universal junction box adaptor.
4. UV stable thermoplastic housing, rated for damp locations.
5. Two LED lamp heads.
6. Internal emergency power unit.

C. Remote Emergency Lighting Units:
1. Emergency Lighting Unit: as indicated on Drawings.
2. Operating at universal nominal voltage
3. Wall with universal junction box adaptor.
4. UV stable thermoplastic housing, rated for damp locations.
5. LED lamp heads.
6. External emergency power unit.

2.5 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Operating at universal nominal voltage
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
4. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.6 EMERGENCY SWITCHING MODULE

A. Emergency Switching Module Type A:

1. Switching module shall be installed in conjunction with AC ballast/driver intended for normal luminaire operation. Designed to automatically switch over to emergency circuit upon loss of normal power via internal voltage sensing device.

2. Allows standard switching of Luminaire on normal power circuit.

3. Inputs:

a. Normal power switched circuit

b. Normal power unswitched circuit

c. Emergency power unswitched circuit

4. Output: Connection to AC ballast

5. Rated: 120-277V, 3-amps for single luminaire installation only

6. UL 924 listed for Emergency Lighting and Power Equipment UL 1008?

7. Design Make: Bodine GTD Series

B. Emergency Switching Module Type B:

1. Switching module shall be installed in conjunction with normal and emergency power circuits intended for switched and automatic emergency luminaire operation. Designed to automatically switch over to emergency circuit upon loss of normal power via internal voltage sensing device.

2. Allows standard switching of Luminaire on normal power circuit.

3. Inputs:

a. Normal power switched circuit

b. Normal power unswitched circuit

c. Emergency power unswitched circuit

4. Output: Connection to lighting circuit maximum of 20 amps

5. Rated: 120-277V, 20-amps for multiple luminaires on the circuit

6. UL 924 listed for Emergency Lighting and Power Equipment

7. Design Make: Bodine GTD20 Series

2.7 LIGHTING SCHEDULES

A. Luminaire Schedule:

1. Luminaire schedule is found on the drawings.

B. Lighting Control Schedule:

1. Lighting control schedule is found on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions, under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

3.2 PRE-INSTALLATION MEETING

A. A factory authorized manufacturer’s representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation meeting after receipt of approved submittals to review the following:

1. Confirm the location and mounting of all digital lighting control devices, with special attention to placement of occupancy and photo sensors.

2. Review the requirements for low-voltage control wiring and termination.

3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

3.3 COORDINATION

A. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper luminaire location only. Locate occupancy sensors and photo sensors per the manufacturer's recommendations. Coordinate the proper arrangement with all other ceiling mounted items. Contract Documents indicate luminaire characteristics (type), quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible luminaire flange/trim type.

B. General

1. Install interior luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation'', NEMA standards, and with recognized industry practices.

2. Provide luminaires and/or luminaire outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Engineer.

3. Make installation such that the luminaire is free of finger marks, flaws, scratches, dents or other imperfections.

4. Do not use ceiling grid as support for any luminaires. Connect support wires or rods to building structure.

5. Arrangement

a. Align edges of luminaires with walls or other building elements. Where indicated by dimensions or indicated on Drawings, maintain indicated arrangement.

b. For wall to wall installed luminaires, field measure length required after completion of the wall construction and prior to ordering the luminaires. Fabricate in largest lengths allowable.

6. Recessed Mounting

a. Verify ceiling construction and material prior to ordering luminaires. Provide plaster frames for plaster ceilings and flanged frames for drywall

ceiling. Provide necessary mounting hardware and accessories to adapt luminaire to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing 'lay-in' type luminaires, each Luminaire shall be supported completely independent of the ceiling system by way of 12-AWG galvanized steel support wires. Support wires shall be attached from all four corners of the Luminaire housing to the building structure. Each support shall be capable of supporting 100 pounds. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity.

7. Stem Mounting

   a. Use self-aligning hangers in canopies for hanging luminaires true to vertical. Do not deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four times luminaire weight. Align continuous rows of luminaires maintaining luminaires level without rotation about the longitudinal axis. Rigidly support outlet box independent of ceiling system from building structure. Where obstructions prevent direct support of outlet, provide offset or trapeze hangers of outlet box. Stem shall be supported directly from building structure on centers as called for by the manufacturer. There shall be a minimum of two stems per individual four foot luminaire, and three stems per individual eight foot luminaire for steel luminaires. Extruded aluminum luminaires shall have hangers as called for by the manufacturer.

   b. Provide brackets from the manufacturer of the same finish and material as the luminaires to present a seamless continuous row mounting appearance. Provide continuous row mounting brackets between all adjoining luminaires.

8. Surface Ceiling Mounting

   a. Mount surface luminaires tight to surface without distorting surface. Space luminaires in continuous rows to correspond to ceiling joint intersections. Continuous row luminaires may be fed by a single outlet where luminaires contain approved wireways and suitable wiring is used. Provide hangers for each luminaire, each rated to support four times the luminaire weight. Provide offset or trapeze hangers where required. Supports shall be provided on a maximum of 4 foot centers with a minimum of two hangers per individual four foot luminaire and three hangers per individual eight foot luminaire. Hangers shall be supported from the building structure and independently from ceiling system or other building services.

   b. Fasten luminaires securely to structural supports.

9. Suspended Chain Mounting only allowed in mechanical and electrical rooms, and only where called out in Lighting Fixture Schedule as means of suspending. Provide chain supports at each end of luminaire and no more than 4 foot on centers.

3.4 DELIVERY, STORAGE, AND HANDLING

A. Luminaires and equipment shall be delivered with UL and manufacturer's labels intact and legible in factory fabricated containers.

B. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.

C. Handle interior lighting luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged luminaires or components; replace with new.

3.5 SEQUENCING AND SCHEDULING

A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.

B. The contractor shall provide the lighting control systems manufacturer with three weeks written notice of the system startup and adjustment date.

3.6 REUSE AND REPAIR OF EXISTING LUMINAIRES

A. Reuse existing luminaires only where called for. Perform the following work, as required, to upgrade existing luminaire. Replace faulty, leaking, or noisy ballast. Replace broken, damaged, worn, or faulted lamp sockets. Provide new luminaire wire. Provide new acrylic lens system to match existing, where existing is broken. Re-lamp luminaires. Completely damp clean lens and interior of luminaires.

B. If ballasts have leaked, remove material deposited in luminaire. Assume material was PCB contamination, or a test samples to show material is not PCB and submit a report. Dispose of material as required by EPA, including clean-up materials used. Dispose of ballast which does not have non PCB label in PCB containers and have containers taken to EPA approved incinerators. Follow all EPA regulations for transporting material.

C. New luminaires may be provided to replace existing luminaires scheduled to remain or be reused, subject to shop drawing approval.

3.7 REMOVAL OF BALLAST IN EXISTING LUMINAIRES

A. Assume ballast contains PCB materials unless labeled otherwise or test samples to show materials are not PCB; submit test report. Remove all ballast from existing luminaires indicated on contract documents. Dispose of all ballast which do not have non-PCB

labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing luminaire, remove material deposited in luminaire and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owners representative.

3.8 REMOVAL OF LAMPS IN EXISTING LUMINAIRES

A. Assume all fluorescent lamps contain Mercury materials unless labeled otherwise or test samples to show materials do not contain Mercury and submit test report. Remove all lamps from existing luminaires indicated on contract documents. Dispose of all lamps which do not have non-Mercury labels in compliance with the requirements of the New York State Department of Environmental Conservation and all applicable Federal Laws. Follow all regulations for transporting materials. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

3.9 LAMPS

A. Provide lamps in all luminaires.

B. Replace any lamp whose color is determined to be unsatisfactory. Replace all HID lamps which are found to have failed during the 12 month warranty period.

C. All lamps shall be new and unused. If permanent lighting system is used for temporary construction lighting, lamps shall be replaced upon turn over to Owner.

D. Furnish stock or replacement lamps amounting to 15%, but not less than 4 lamps in each case, of each type and size lamp used in each type luminaire. Deliver replacement stock as directed to Owner's storage space.

3.10 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
3. Interconnect to ground lug in pole base.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.11 SPARE PARTS

A. Provide the following spare parts to the owner with sign-off receipt prior to job close-out:

1. 10% of driver types

2. Designer choice.

3. Lenses / Diffusers

a. 10% of fixtures with available lenses by fixture type NOT lens type

b. Where lenses come in rolls – provide 50 feet of roll or 1 feet per 100 ft used on job

c. Where spare parts not available: provide (1) one additional fixtures

3.12 FINAL CLEANING

A. Prior to acceptance, damp clean diffusers, glassware, trim, reflectors, lamps, louvers, lens and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out lamps and failed components.

END OFSECTION 265100

SECTION 265110 – LIGHTING CONTROLS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide startup of all lighting control systems by a factory authorized manufacturer's representative. Provide initial system settings and owner training.

B. Provide Lighting System Functional Testing as described in this section by a factory authorized manufacturer's representative hereby referred to as the Testing Agent.

C. Unless otherwise noted all wall mounted devices shall be Ivory, all ceiling mounted devices shall be White.

D. Lighting controls shall be from one factory authorized manufacturer's representative acceptable manufacturers are:

1. Steinel
2. Crestron - Zumnet
3. Wattstopper LMRC-Series
4. Acuity Brand– Nlight series

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Cover plates
2. Switches
3. Room Controllers
4. Low-Voltage Switches
5. Occupant Sensor Controls
6. Dimmer Switches
7. Time Clock
8. Startup and Testing

1.3 SUBMITTALS

A. Submit shop drawings as described in Section 260010. Shop drawings shall include lighting control system components, system wiring diagrams, BOM, all shall be

submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab.

1. Switches
2. Low Voltage Switches
3. Timer Switches
4. Time Clocks
5. Room Controllers and Wiring Diagrams
6. Occupancy Sensors

B. Submit for approval information detailing startup of the lighting control systems and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they authorize said individual(s) to perform this work. Submittal will be rejected if this information is not included.

C. Submit for approval a testing plan for all lighting control systems. Testing plan shall, at a minimum, observe and record all items described in the "Lighting System Functional Testing" part of this section and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they authorize said individual(s) to perform this work. Submittal will be rejected if this information is not included.

1.4 QUALITY ASSURANCE

A. Codes and Standards

1. NEC:
   a. Shall comply with Articles 220, 410 and 510 as applicable to installation and construction.
2. NEMA:
   a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.
3. UL:
   a. All interior lighting luminaires and components shall be UL listed and labeled.
   b. Comply with all applicable UL standards including UL 486A and B.
4. All work shall comply with applicable local code requirements of the authority

having jurisdiction.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

1.6 MAINTENANCE CONTRACT:

A. Provide an additional 3 year maintenance contract (via approved manufacturer's representative) on all provided lighting controls and systems outlined in this specification and provided for under this contract. Maintenance contract shall provide for two (2) site visit to each building to verify operation and allow for adjustment of any and all devices not operating or operating outside of its initial substantial completion time of acceptance.

B. All software updates released by approved manufacturers equipment shall be provided and installed.

PART 2 - PRODUCTS

2.1 COVERPLATES

A. Provide type 302 stainless steel cover plates with satin finish for general purpose flush devices.

B. Provide utility cover plates for surface mounted devices in mechanical rooms.

C. Provide gasketed cover plates with a hinged cover on a cast aluminum outlet box for all devices in wet areas designated "WP".

2.2 SWITCHES

A. 120-277 VAC, 20 ampere rated.

B. Side or back wired.

C. Quiet operation.

D. Single pole, three way, and four way as called for on the plans.

2.3 MOMENTARY SWITCHES

A. 120-277 VAC, 20 ampere rated.

B. Momentary contact.

C. 2 circuit, 3 position, “center off”.

D. Side wired.

E. Quiet operation.

2.4 WALL MOUNTED LOW-VOLTAGE OCCUPANCY and/or VACANCY

A. 0-10V dimming PIR & 40kHz ultrasonic wall switch occupancy sensor.

B. Adjustable ultrasonic reach setting from 25% - 100%

C. 180° coverage pattern.

D. Manual ON or Automatic ON option.

E. Partial ON and OFF adjustment settings from 10%-70%

F. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model with matching wallplate.

G. Intended for 0–10V dimming for fluorescent and LED luminaires.

H. Controls 120–277V without a power pack, 8 Amp 120-277V rated. Internal power supply generates 0-10V output.

I. Provide one (1) smart remote per project for programming and commissioning. Turn over to owner upon substantial completion.

2.5 ROOM CONTROLLERS

A. Modular, stand-alone one room lighting control system (0-10V dimming and switching) with control of multiple user presets and room occupancy and daylight sensing for daylight harvesting. Provide quantity of controllers per zones, per room as required.

B. Ethernet network connection to a control system.

C. Concealed mounting, self-contained, multi-channel lighting controller designed to communicate with occupancy and photo sensor inputs without the use of external power packs.

D. Shall allow for on-site commissioning controls via an infrared handheld remote control.

E. Lighting loads: Refer to floor plans for quantity of lighting channels per room. Where any room exceeds three channels, provide multiple room controllers networked together for proper system operation.

F. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so the individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.

G. Each load shall at minimum be configurable to operate in the following sequences based on occupancy:

1. Auto-on/Auto-off

2. Manual-on/Auto-off

H. Manual override and LED indicated for each load.

I. Compatible with 120/277 VAC systems.

J. Maximum 20A combined 20A combined load per Room Controller.

K. All digital parameter data programmed into each room controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

L. Room controller shall include:

1. Real time current monitoring

2. Efficient 250 mA switching power supply

3. RJ-45 network ports with integral strain relief and dust covers

4. One dimming output per relay

a. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.

b. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. The LED level indicators on connected dimmer switches shall utilize this new maximum and minimum trim.

c. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0—100% dimming range defined by the minimum and maximum calibration trim.

d. Calibration and trim levels must be set per output channel.

e. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

5. Fade rates for dimming loads shall be specific to connected switch buttons, and the load shall maintain a default value for any connected buttons that do not specify a unique value.

M. Class 2 dimming control signal: 0-10VDC, sinks up to 100mA per channel for control of compatible drivers.

N. UL 2043 Plenum rated.

O. IR window built-in to room controller for commissioning with remote control.

P. Provide (1) infrared remote control for startup, programming, and commissioning.

Q. Provide with digital input/output interface that includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC.

R. Five year warranty.

2.6 LOW-VOLTAGE SWITCHES FOR ROOM CONTROLLERS:

A. On/Raise & Off/Lower dimming control button with led status indicator. Provide the following switch types dependent on the number of zones.

| NUMBER OF ZONES | NUMBER OF BUTTONS | OPERATION |
|---|---|---|
| 1 | 4 | UP/ON, DOWN/OFF, SCENE 1, SCENE 2 (PRESETS) |
| 2 | 4 | UP/ON, DOWN/OFF, SCENE 1/UP ZONE 2, SCENE 2/DOWN ZONE 2 |
| 3 | 6 | UP/ON, DOWN/OFF, SCENE 1, SCENE 2 (PRESETS), UP ZONE A, DOWN ZONE A |
| 4 | 8 | UP/ON, DOWN/OFF, SCENE 1, SCENE 2 (PRESETS), UP ZONE A, DOWN ZONE A, UP ZONE B, DOWN ZONE B |

B. Dimming switch with seven bi-level LED’s to indicate load levels using 14 steps.

C. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.

D. All digital parameter data programmed into each wall switch shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

E. Two RJ-45 ports for connection to the Room Controller network and other devices.

F. Multiple digital wall switches may be installed in a room by simply connecting the to the room controller network. No additional configuration shall be required to achieve multi-level switching.

G. Ramp rate may be adjusted for each dimmer switch.

H. Five year warranty, unless otherwise indicated

I. Shall be of the same manufacturer as the room controller.

2.7 OCCUPANCY SENSORS

A. General:

1. All occupancy sensor layouts have been done using the "design make" sensors. Contractor shall be responsible for providing additional sensors and all associated equipment required to provide coverage for required areas.

2. Type "A" Ceiling Mounted Sensors – Typical Room

a. Minimum 400 square feet of coverage, 360 degree viewing angle.

b. Dual technology. Adjustable sensitivity.

c. Adjustable time delay from 5 to 30 minutes.

d. Install semi-flush in single gang switch box above the ceiling.

e. Two RJ-45 ports for connection to the Room Controller and other devices.

f. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

g. Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.

3. Type "B" Ceiling Mounted Sensors – Large Area

a. Minimum 1,000 square feet of coverage up to 2,000 square feet, 360

degree viewing angle.

b. Dual technology (Ultrasonic/PIR or Microphonic/PIR). Field selectable for either setting or both. Adjustable sensitivity.

c. Adjustable time delay from 5 to 30 minutes.

d. Installs surface mounted in 4" octagon J-box above the ceiling.

e. Sensors connected to Room Controllers:

f. Two RJ-45 ports for connection to the Room Controller and other devices.

g. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

h. Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.

4. Type "C" Ceiling Mounted Sensors

a. Nominal 6.5' X 65' of coverage for corridors.

b. Ultrasonic technology.

c. Adjustable time delay from 30 seconds to 15 minutes.

d. Adjustable sensitivity.

e. Manual sensor bypass.

f. Install surface mounted in single gang switch box above the ceiling.

g. Provide with relay power pack.

2.8 TIMER SWITCH

A. Switch designed to fit decorator style switch plate covers.

B. Ivory color.

C. LCD countdown display

D. Push button scroll adjustable solid state time setting up to 12 hour

E. Integral on/off push button

F. Amperage Capacity: 800W at 120VAC, 1,200W at 277VAC

G. Power Specification: 120-277 Volt AC, 50/60 Hz

H. Approvals: UL, CSA

2.9 DIMMER SWITCHES

A. 0-10VDC Dimmers:

1. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model with matching wall plate.

2. Provide accessory 120-277V input power pack to power accessory sensors as indicated and 10V control power for dimming switch

3. Vertical linear slider for dimming

4. Intended for 0–10V dimming for fluorescent and LED luminaires

5. Controls 120–277V without a power pack, 8 Amp 120-277V rated. Internal power supply generates 0-10V output.

6. Provides 3-way preset switching functionality

2.10 PHOTO SENSOR

A. Digital daylighting sensor shall work with the Room Controllers describe in this section to provide automatic dimming daylight harvesting capabilities.

B. Continuously monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight.

C. Shall provide the option, when daylight contribution is sufficient, of turning the lights off or dimming the lights to a field-selectable minimum level.

D. Shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.

E. Shall provide adjustable cut-off time. Cut –off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.

F. Wall switch override shall allow occupants to control lighting level with dimming wall switches.

G. Automatically establishes application specific set points following manual calibration using a wireless configuration tool or PC with appropriate software. For switching operation, an adequate dead-band between the ON and OFF set points for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm

shall maintain the design lighting level in each zone.

H. Install in location recommended by the manufacturer.

I. Field of View: 60 Degree cone.

J. Sensitivity: 1-6,553 foot-candles (10-70,536 lux).

K. LED status and configuration indicators.

L. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool.

M. One RJ-45 port.

N. Connects to room controller via Cat.5e patch cable without the need for external power packs.

O. Five year warranty.

P. Shall be of the same manufacturer as the room controller.

## 2.11 LIGHTING CONTACTORS

A. Description: Electrically operated and electrically held, combination-type lighting contactors with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices and, matching the NEMA type specified for the enclosure.

## 2.12 LIGHTING SCHEDULES

A. Luminaire Schedule:

1. Luminaire schedule is found on the drawings.

B. Lighting Control Schedule:

1. Lighting control schedule is found on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions, under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Installer shall return to site at the end of one year of operation and walk the site with the owner verifying operation of all devices installed, and make any corrections within 1 week of date of initial walk.

3.2 SEQUENCING AND SCHEDULING

A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.

B. The contractor shall provide the lighting control systems manufacturer with three weeks written notice of the system startup and adjustment date.

3.3 INSTALLATION OF CONTACTORS

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 INSTALLATION OF WIRING

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is ¾”.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's written instructions.

D. Size conductors in accordance with lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 OCCUPANCY SENSORS

A. Provide all necessary mounting brackets, wiring, low voltage transformers and control relays required to provide control of areas indicated.

B. Provide initial time delay and sensitivity settings per owner's representative.

C. Install in location as recommended by the manufacturer.

D. Refer to "Lighting System Functional Testing" part of this section for additional information.

3.6 CONTROL WIRING

A. Provide all required low-voltage control wiring for lighting control system components.

B. Provide pre-terminated Cat.5e or better cable with RJ-45 connectors to connect devices in Room Controller network. Cables shall be of same manufacturer as the Room Controllers or listed as a manufacturer approved connectivity solution.

3.7 LIGHTING SYSTEM FUNCTIONAL TESTING

A. Lighting system functional testing shall comply with the following requirements:

1. Provide plan markup which indicates the exact location of each sensor, direction of aim, and certify on the plan that the direction of aim and placement are in compliance with manufacturer's requirements. Include this plan with the Operation & Maintenance Manuals.

2. Occupancy Sensor Controls:

a. Certify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations.

b. All devices shall be tested. Verify the following:

1) Where occupant sensor controls include status indicators, verify correct operation.

2) The controlled lights turn off or down to the permitted level within the specified time.

3) The lights turn on only when manually activated.

4) The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

3. For Time – Switch Controls:

a. Verify that timers are properly programmed with weekday, weekend and holiday schedules.

b. Provide documentation to the Owner of time-switch controls programming including weekday, weekend, and holiday schedules and set-up and preference program settings. Include a copy in testing documentation package for approval by the Engineer.

c. Verify time of day and day of week are properly set.

d. Verify that any battery back-up is installed and energized.

e. Verify that any override timer is set for less than 2 hours.

f. Simulate occupied condition and verify the following:

1) All lights can be turned on or off by respective area control switch.

2) Light switches control only those lights in the enclosed area where the switch is located.

g. Simulate unoccupied condition and verify the following:

1) Non-exempt lights turn off.

2) Manual override switches allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

4. Create a log of deficiencies noted during testing. Correct all deficiencies and update log with corrective action records.

5. Complete and submit as part of the Operation and Maintenance Manuals the submitted and approved lighting testing plan.

3.8 TRAINING

A. Upon completion of the system startup, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the lighting control system. Include sign in sheet with Operation & Maintenance Manuals.

3.9 SPARE PARTS

A. Provide the following spare parts to the owner with sign-off receipt prior to job close-out:

1. (10) ten Low-voltage switches

2. 10% extra of: Room Controllers, sensors, etc.

3.10 FINAL CLEANING

A. Prior to acceptance, damp clean diffusers, glassware, trim, reflectors, lamps, louvers, lens and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out lamps and failed components.

END OF SECTION 265110

SECTION 271000 - HORIZONTAL AND BACKBONE COMMUNICATION CABLING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Provide (25) installed spare plenum rated cat. 6A cables. Each installed cable shall include up to 300-feet of specified plenum rated cat. 6A cable with termination, testing, and labeling at each end. Provide up to 20-feet of V2400 surface metal raceway, surface metal backbox, outlet, and RJ-45 plenum rated cat. 6A jack at station end for each cable. Provide required supports and sleeves for distribution.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

P. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.

Q. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

1.3 SCOPE

A. Horizontal cabling includes STP between public address system peripherals, access control system, and security system equipment and devices as required by the manufacturer and called for on the drawings.

B. Horizontal cabling includes plenum rated Category 6A UTP from the Intermediate Distribution Frames (IDF) to the outlets as called for on the drawings. The horizontal cabling includes all horizontal cables, patch panels, patch cables, termination, testing, and mechanically terminated jacks/inserts and faceplates in the work area and the mechanical termination in the IDF.

C. UTP Backbone cabling includes new interior and exterior multipair-pair UTP cable between MDFs (Main Distribution Frames), IDFs, and buildings. Additional required components include 110-blocks, termination, testing, direct buried splice cases, lightning protection, and required grounding.

D. Backbone cabling includes interior and exterior multi-mode and single-mode optical fiber run between IDFs (Intermediate Distribution Frames) and between buildings. Additional required components include patch panels, direct buried splice cases, termination, and testing.

E. Horizontal cabling includes audio and video cabling as indicated on the drawings.

F. This section includes minimum requirements for the following:

1. Plenum rated Cat. 6A Cabling

2. Plenum rated Cat. 6A Patch Cables

3. Connecting Hardware

4. 100 Ohm UTP Cable Testing

1.4 QUALITY ASSURANCE

A. All cable shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated,

equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by a BICSI RCDD (Registered Communication Distribution Designer.)

2. Installation Supervision: Installation shall be under the direct supervision of Level 1 or 2 BICSI Certified Installer, who shall be present at all times when Work of this Section is performed at Project site.

C. Provide with the submittals, documentation from an independent testing agency indicating that the complete assembly including cable and termination hardware has been tested and meets the performance criteria called for.

D. Provide contractor or sub-contractor experienced in all telephone and fiber splicing and trained and experience with the fusion splicing equipment to be used on this project.

E. Materials and work specified herein shall comply with the applicable requirements of:

1. ANSI/TIA/EIA – 568-A

2. ANSI/TIA/EIA – 568-C

3. ANSI/TIA/EIA – 569-B

4. NFPA 70 - 2014

5. BICSI Telecommunications Distribution Methods Manual

6. FCC 47 CFR 68

7. NEMA - 250

8. NEC - Articles 770 and 800

1.5 SOURCE QUALITY CONTROL

A. Factory test UTP cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

1.6 SUBMITTALS

A. Manufacturers catalog sheets, specifications, and installation instructions for all products in this section.

B. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

C. Test results for all telephone and data UTP cable, and fiber splicing, new fiber cable installations performed in this project. Submit immediately upon completion of cable installation for review and include second copy in final O&M manuals.

1.7 WARRANTY

A. Contractor shall provide one (1) year parts and labor warranty against defective workmanship and/or system component failure.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide an end-to-end connectivity solution in which all horizontal cabling and connecting hardware are made by the same manufacturer. At a minimum, all connecting hardware and UTP patch panels shall be from the same manufacturer. Refer to specification section 271100 for additional information regarding patch panels.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing 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.

C. RoHS compliant.

D. Outer Jacket Color Coding, horizontal and patch cables:

1. Data – Blue

2. Telephone – White

3. Security – Yellow

4. BMS – Orange

5. Wireless Access Points – Purple

6. IP Cameras – Green

2.2 PLENUM RATED CAT. 6A CABLING (100 OHM UNSHIELDED TWISTED PAIR)

A. Shall be plenum rated Category 6A type cable compliant with the requirements of the most current edition of the TIA/EIA-568-B.2-10-2008 standard.

B. Physical Characteristics:

1. Shall be CMP, plenum rated.

2. Conductor shall be 23 AWG solid bare annealed copper.

3. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.

4. The diameter of the insulated conductor shall be .023 in. maximum.

5. Shall consist of (4) twisted pairs.

6. Shall be suitable for the environment in which they are to be installed.

7. The color coding of pairs shall be:

| | |
|---|---|
| Pair 1 | W-BL; BL |
| Pair 2 | W-O; 0 |
| Pair 3 | W-G; G |
| Pair 4 | W-BR; BR |

8. The overall diameter of the cable shall be no greater than 0.295 inches.

9. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.

10. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius without jacket or insulation cracking.

C. Transmission Characteristics:

1. Cable shall be tested & characterized to 625 MHz.

a. Cable shall exhibit a PSNEXT loss of at least the following:

| Frequency MHz | NEXT dB |
|---|---|
| 1.0 | 73.3 |
| 4.0 | 64.3 |
| 10.0 | 58.3 |

| | |
|---|---|
| 16.0 | 55.2 |
| 20.0 | 53.8 |
| 31.25 | 50.9 |
| 62.5 | 46.4 |
| 100.0 | 43.3 |
| 200 | 38.8 |
| 250 | 37.3 |
| 300 | 36.1 |
| 400 | 34.3 |
| 500 | 32.8 |
| 625 | 31.4 |

b. Cable shall exhibit an Attenuation loss of less than the following:

| Frequency MHz | Attenuation dB |
|---|---|
| 1.0 | 2.1 |
| 4.0 | 3.8 |
| 10.0 | 5.9 |
| 16.0 | 7.5 |
| 20.0 | 8.4 |
| 31.25 | 10.5 |
| 62.5 | 15.0 |
| 100.0 | 19.1 |
| 200 | 27.6 |
| 250 | 31.1 |
| 300 | 34.3 |
| 400 | 40.1 |
| 500 | 45.3 |
| 625 | 51.2 |

c. Cable shall exhibit a Return loss according to the following:

| Frequency MHz | Return Loss (dB) |
|---|---|
| 1 | 20.0 |
| 4 | 23.0 |
| 10 | 25.0 |
| 16 | 25.0 |
| 20 | 25.0 |
| 31.25 | 23.6 |
| 62.5 | 21.5 |
| 100 | 20.1 |
| 200 | 18.0 |
| 250 | 17.3 |
| 300 | 16.8 |
| 400 | 15.9 |
| 500 | 15.2 |

| | |
|---|---|
| 625 | 14.5 |

D. Design Make: Belden 10GX13 Series

E. Acceptable Manufacturers:

1. OCC
2. Bertek
3. Commscope

2.3 PLENUM RATED CAT. 6A PATCH CABLES

A. Meets all above requirements for 100 OHM unshielded twisted pair cable (Plenum rated Cat. 6A cable), except stranded conductors.

B. Factory terminated RJ-45 male at both ends with strain relief at ends of the cable.

C. 6’ or 2-meter in length minimum.

D. Design Make: Belden AX3600XX Series

E. Acceptable Manufacturers:

1. OCC
2. Bertek
3. Commscope

2.4 CONNECTING HARDWARE

A. Color shall be electric white or ivory unless otherwise noted below.

B. Physical Characteristics

1. Faceplates shall be provided with labels and plastic label protector strip.
2. Faceplates shall be modular keystone jack type, 4-port minimum or 1-gang opening with mounting bezels to accept combination keystone jacks and multimedia jacks.
3. Each jack shall be an individually constructed unit and shall snap mount into the faceplate keystone opening.
4. Jack housings shall be high impact 94 V-0 rated thermoplastic.
5. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A.

6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.

7. Housing shall be ultrasonically welded for tamper resistance.

8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.

9. UTP jack IDCs shall accept a minimum of 20 re-terminations without degradation of electrical or mechanical performance.

10. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.

11. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.

12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.

13. Jack termination shall follow the industry standard 110 IDC. Includes insulated barrier between IDC contacts.

14. Jacks shall have a designation indicating the cable type on the nose which can be plainly seen from the front of the faceplate.

15. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.

16. Jacks shall terminate 22-26 AWG stranded or solid conductors.

17. Jacks shall include wire retention stuffer cap that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.

18. Jacks shall be color code marked with both T-568A and T-568B wiring.

C. RJ-45 Jack Design Makes:

1. Face color shall match outer sheath cabling color.

2. Cat. 6A Data Jacks

3. Voice Jacks

4. Design Make: Belden AX10XXXX Series

D. Multimedia & Accessory Jack Design Makes:

1. Blank Jack Snap-In –Belden AX102262

2. Type F Jack – Belden AX102904

3. S-Video Jack – Belden AX101883

4. RCA Three Color Stereo Audio/Video Jack – Belden AX101879

5. VGA HD-15 pin barrel connector – Belden AX102336

6. Other components and mounting bezels/inserts as required for special mounting conditions and for floor boxes, surface raceways and modular furniture.

E. Faceplate Design Makes:

1. Single Gang 4-Port Faceplate w/ ID Windows – Belden AX102249

2. Single Gang Faceplate for Combination Multimedia & Data Jacks – Belden AX101747. Provide w/ required bezels/inserts

F. Acceptable Manufacturers:

1. Panduit (NetKey not Acceptable)

2. Hubbell

3. OCC

4. Leviton

5. AMP

6. TE Connectivity

7. CommScope

2.5 100 OHM UTP TESTER

A. User Interface

1. 240 x 320 backlit LCD display

2. Date stamp of all tests

3. Tone generation audio warning

B. Physical interface shall be modular RJ-45 connector and a serial port with DB-9 connector.

C. Shall test cable for compliance with the following standards:

- TIA Category 3, 5E, 6 and 6A: 100 Ohm
- ISO/IEC 11801 and EN 50173 Class C and D: Link

- ISO/IEC 11801 and EN 50173 Class C and D (new): Permanent Link or Channel
- Aus/NZ Class C and D: Basic Link or Channel
- STP cabling, (IBM Type 1, 150 □)
- ANSI TP-PMD IEEE 802.3 10BASE5, 10BASE2: Ethernet with coaxial cabling
- IEEE 802.3 10BASE-T, 100BASE-TX, 1000BASE-T: Ethernet with twisted pair cabling IEEE 802.5: Token Ring, 4 Mbps or 16 Mbps

D. Shall perform the following tests as a minimum:

- NEXT, NEXT @ Remote
- Wire Map
- Characteristic Impedance
- Length
- DC Loop Resistance
- Propagation Delay Return Loss (RL), RL @ Remote
- Delay Skew
- Attenuation
- Attenuation-to-Crosstalk Ratio (ACR), ACR @ Remote
- Power Sum ACR, PSACR @ Remote
- ELFEXT, ELFEXT @ Remote
- Power Sum ELFEXT, PSELFEXT @ Remote
- Power Sum NEXT, PSNEXT @ Remote

E. Shall use injector for complete wire mapping and TDR for determining cable length.

F. Shall measure NEXT for all six pair combinations and Attenuation on all four pairs from 1.0 to 500 MHz.

G. Design Make: Fluke “DSX-5000” or Approved Equal

H. Acceptable Manufacturers:

1. WaveTek

2. Lantek

2.6 BONDING HARNESS

A. Shall be used to ground the shields of the spliced cables.

B. Bonding harness shall be 14 AWG and sized according to closure.

C. Adhere to all manufacturer installation guidelines.

D. Design Make: 3M or Approved

2.7 BONDING CONNECTORS

A. Shall consist of a base and upper member, two securing nuts and a plastic shoe to aid connector installation and protect the conductors.

B. Base and upper members shall be made of tin plated tempered brass, slightly curved so as to exert a continuous spring form on sheath and shield after clamping.

C. Design Make: 3M Telecommunication Access Division Products or equal

1. 3M Part # 4460 – S Shield Bond Connector for cables of greater than 100 pair.

2. #M Part # 4460 – D Shield Bond Connector for cables of less than 100 pair.

2.8 GROUNDING BRAID

A. Provide #6 AWG insulated green 600-volt THHN conductor from telecom equipment grounding point back to equipment ground bus in nearest 120V panelboard.

B. All taps shall be made with UL listed lugs.

C. Provide ½" EMT conduit to protect ground conductor from the equipment grounding point back to the 120V panelboard.

2.9 COAXIAL DROP CABLE

A. UL listed NEC type CMP or CATVP, constructed in accordance with UL910 Steiner Tunnel flame test.

B. Provide RG-6/U cable from backbone trunk tap or splitter to wall mounted outlet.

C. Physical Characteristics:

1. White colored outer jacket.

2. 18 AWG copper center conductor.

3. 100% Dufoil® aluminum polyester tapes.

4. 65% aluminum braids.

5. Overall Flamarrest® plenum rated jacket.

6. Suitable for -20°C to +75°C temperatures.

7. Nominal Capacitance: 16.5 $^{pf/}$ft.

8. Nominal Impedance: 75 ohm

9. Outer Diameter .222"

10. Must fall within the following Attenuation values:

| Frequency (MHz) | Nominal Attenuation (dB/100 ft.) |
|---|---|
| 1 | .3 |
| 10 | .7 |
| 50 | 1.6 |
| 100 | 2.2 |
| 200 | 3.0 |
| 400 | 4.6 |
| 700 | 6.6 |
| 1000 | 8.2 |

D. Design Make: Belden 82248 or Approved Equal

2.10 RG-11 COAXIAL BACKBONE CABLE

A. Provide plenum backbone cables between CERs and taps as shown on the CATV riser diagram.

B. Cable shall be UL listed NEC Type CMP or CATVP, constructed in accordance with UL910 Steiner Tunnel flame test.

C. White colored outer jacket.

D. Provide backbone cable with the following guidelines:

1. FEP- Fluorinated Ethylene Propylene outer jacket.

2. Shall be plenum rated Type RG-11/U, solid 14 AWG center conductor.

3. Nominal Impedance of 75 Ω

4. Nominal Capacitance of16.2 pF/ft.

5. 100% Duofoil® shield and tinned copper braid w/ 63% coverage.

6. Must fall within the following Attenuation values (dB/100ft.)

| Frequency (MHz) | Nom. Attenuation |
|---|---|
| 1.0 | .2 |
| 10.0 | .4 |
| 100.0 | 1.5 |
| 200.0 | 2.2 |
| 700.0 | 4.5 |
| 1000.0 | 5.5 |

E. Design Make: Belden 89292

F. Acceptable Manufacturers:

1. General Cable

2. Commscope

3. Berk-Tek

2.11 LABELING

A. All labels shall be typed on self-adhesive label strips where a plastic protector is not present on the termination equipment.

B. All letters and numbers shall be capital and the same font, black colored text on white background, closest to size 12 ARIAL FONT as possible.

C. Label maker Design Make: DYMO or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Labeling

1. Label horizontal all cable outlets to mirror the labeling on the demarc end or wiring closet end. All labels shall be typed indicating CER, Patch Panel, and Port Number.

B. Horizontal Cable Runs:

1. All interior cabling shall be installed concealed inside the wall cavities and ceiling space. Provide a continuous ENT or innerduct raceway system in accordance with NEC Article 800 for horizontal cable runs through all inaccessible ceiling (drywall) and wall cavity spaces. All flexible raceway system runs shall be securely attached to ceiling joists and wall studs. The flexible raceway system shall be adequately supported and routed to allow the addition and removal of cables in the future.

2. Provide open top “J-Hook” cable hangers located 3-feet on center for all wiring installed above recessed drop ceilings. Securely attach cable hangers to building structure.

3. Refer to specification section 260533 – Raceways for maximum cable fill in raceway systems.

4. Where larger cable quantities are required to share a single raceway refer to EIA/TIA-569 Conduit Sizing Table 4.4-1.

5. All new device outlets in finished areas shall be flush mounted in the walls.

6. Provide surface raceway for all wiring installations in unfinished areas and conduit for all areas with no ceiling open to the structure.

7. All exterior cabling shall be run in direct buried conduit.

8. Provide separate pathways for all control, video, and signal wiring from 120V branch circuiting.

9. Suspend cabling that is not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

10. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

11. Provide all sleeves as required for routing of cables.

12. Provide firestopping at all firewall and floor penetrations.

13. Do not untwist Cat. 6 cable pairs more than 0.5 in. when terminating.

14. Provided inner duct as required to route A/V signal cabling in plenum ceiling spaces. Inner duct shall be 1 ½" diameter, plenum rated, and have pull tape. Design Make: Carlon CH4X1C-350.

15. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.

16. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

17. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

18. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in at terminations.

19. Maintain the following separation from EMI Sources:

    a. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

    b. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

        1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
        2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

c. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

d. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 12 inches.

e. Power cable - 6 in.

f. Transformers - 36 in.

20. Do not install with more than 110N pull force.

3.2 UTP CABLE TESTING

A. General

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of each applicable ANSI/TIA/EIA section listed above for each cable type.

2. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

3. The testing parameters called for in this section shall apply for up to 90 meters of horizontal cable, a work area equipment cord, an RJ45 outlet and 2 cross connect connections in the closet.

4. The test parameters shall include Wire Map, Length (report only), Attenuation and NEXT.

5. Wire Map - The wire map test shall verify pair to pin termination at each end and check for connectivity errors. The wire map shall indicate the following for each of the eight conductors:

a. Continuity to the remote end

b. Shorts between any two or more conductors

c. Crossed pairs

d. Reversed Pairs

e. Split Pairs

f. Any other miswiring

6. Attenuation - The link attenuation and NEXT of all cables shall be tested. The

link is the sum of the attenuation of all connecting hardware, patch and equipment cords, and cable. The following tables indicate the acceptable values:

| **Attenuation** | | | |
|---|---|---|---|
| **Frequency (MHz)** | **Category 3 (dB)** | **Category 5e/6 (dB)** | **Category 6A (dB)** |
| 1.0 | 3.2 | 2.0 | 2.1 |
| 4.0 | 6.1 | 4.1 | 3.8 |
| 10.0 | 10.0 | 6.5 | 5.9 |
| 16.0 | 13.2 | 8.2 | 7.5 |
| 20.0 | - | 9.3 | 8.4 |
| 31.25 | - | 11.7 | 10.5 |
| 62.5 | - | 17.0 | 15.0 |
| 100.0 | - | 22.0 | 19.1 |
| 155 | - | 28.1 | 24.1 |
| 200 | - | 32.4 | 27.6 |
| 300 | - | 41.0 | 34.3 |
| 350 | - | 44.9 | 37.2 |
| 400 | - | - | 40.1 |
| 500 | - | - | 45.3 |
| 625 | - | - | 51.2 |

| **PS Next (worst pair to pair)** | | | |
|---|---|---|---|
| **Frequency (MHz)** | **Category 3 (dB)** | **Category 5e/6 (dB)** | **Category 6A (dB)** |
| 1.0 | 40.1 | 70.3 | 73.3 |
| 4.0 | 30.7 | 61.2 | 64.3 |
| 10.0 | 24.3 | 55.3 | 58.3 |
| 16.0 | 21.0 | 52.2 | 55.2 |
| 20.0 | - | 50.7 | 53.8 |
| 31.25 | - | 47.8 | 50.9 |
| 62.5 | - | 43.3 | 46.4 |
| 100.0 | - | 40.3 | 43.3 |
| 155 | - | 37.4 | 40.4 |
| 200 | - | 35.7 | 38.8 |
| 300 | - | 33.1 | 36.1 |
| 350 | - | 32.1 | 35.1 |
| 400 | - | - | 34.3 |
| 500 | - | - | 32.8 |
| 625 | - | - | 31.4 |

B. Data reporting and accuracy

1. General: a Pass or Fail result for each parameter shall be determined by the allowable limits for each parameter. If the test result of a parameter is closer to the test limit than the accuracy of the tester it shall be marked with an asterisk.

Data at all measured points shall be uploaded to a P.C. and printed on a laser printer.

2. Wire Map: Wire map tests shall be marked "Pass" if wiring is determined correct.

3. Length: Test results shall be reported in meters.

4. Attenuation: Report the attenuation value and the frequency at point of failure or the highest frequency passed. Measured attenuation values lower than 3dB used for a pass/fail determination. Report the attenuation per unit length for links longer than 15 meters. Attenuation shall be measured from 1 MHz to 16 Mhz (Category 3) or 350 Mhz (Category 5e/6) or 500 MHz (Category 6A) in the steps listed in the tables above.

5. NEXT: Report the NEXT value and "pass or fail" for samples based on the following:

| Frequency Range (MHz) | Maximum Step Size (MHz) |
|---|---|
| 1-31.35 | 0.15 |
| >31.25-100 | 0.25 |

C. Submit copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job.

3.3 SHIELD BOND CONNECTORS

A. Install Bonding Connectors so as not to damage the conductors in the cable.

B. Provide Bonding Connector and bonding conductor on all armored optical fiber cables and all optical fiber installed with metallic strength members, per manufacturer recommendations and as called for in the section.

3.4 GROUNDING BRAID

A. Adhere to all manufacturer installation guidelines.

B. Provide ground braid across all copper backbone cable sheath openings at splice enclosures. If an existing splice enclosure is reused, and is found to be missing proper grounding/bond per this section, provide labor and materials to bring it up to these standards.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 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. Connecting Blocks: (1) one of each type.
2. Cover Plates: (3) three of each type.
3. Jacks: (10) ten of each type.
4. Multiuser Telecommunications Outlet Assemblies: (1) one of each type.
5. Patch-Panel Units: (1) one each type.
6. Plugs: (10) ten of each type.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.

b. Label each unit and field within distribution racks and frames.

5. Identification within jacks Fields in Equipment Rooms and Wiring Closets: Label each jacks and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

6. Uniquely identify and label work area cables extending from the Multiuser Telecommunication Outlet Assembly (MUTOA) to the work area. These cables may not exceed the length stated on the MUTOA label.

C. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

D. All Wall Plates and Cables are to be numbered per owners IT standards and as follows:

1. Patch panels shall be labeled and match wall plate numbering.

2. Patch cables shall be wire wrap labeled, switch side end is labeled with the patch port and patch port end is labeled with the switch port.

3. Cables shall be wire wrap labeled with the same faceplate numbering scheme on both ends behind the wall plate and patch panel.

END OF SECTION 271000

SECTION 283100 - FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Labeling of addressable devices to be approved by owner and each addressable device shall be provided with a custom label designation (e.g. M1-44) in black text on an adhesive backed plastic label. Labeling on device to be by Electrical Contractor (EC).

C. During the periods of active construction, within the project area, the contractor shall remove smoke detectors in the areas affected by construction and provide temporary heat detectors in their place. Upon completion of construction new detectors shall be provided at these locations. Refer to floor plans for additional information.

D. During the periods of active construction, within the project area, the contractor shall remove any and all existing notification appliances and notification appliances in their place, minimum candela shall be 30cd. Upon completion of construction new detectors shall be provided at these locations. Refer to floor plans for additional information.

1.2 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Control Modules
2. Input Modules
3. Remote Test Station
4. Manual Pull Stations, Double action
5. Initiation Device Base
6. Smoke Detectors
7. Duct Mounted Smoke Detectors
8. Heat Detectors
9. Visual Notification Appliances.
10. Audible/Visual Notification Appliances
11. Batteries and Charger

1.3 QUALITY ASSURANCE

A. All installations shall be accompanied in a professional manner by qualified personnel regularly engaged in and have a minimum of 5 years of experience in this type of Work. All fire alarm installers shall possess a state license for installation of fire alarm systems where required.

B. System supplying manufacturer shall have at a minimum a NICET level III certified individual on staff, and installing contractor shall have at minimum a NICET Level II individual for installation for said project. Certifications shall be provided as part of the submittal process.

C. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

D. Materials specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)

    a. Article 760 - Fire Alarm Systems

2. The following National Fire Protection Agency (NFPA) standards:

    a. NFPA 72 - National Fire Alarm Code

    b. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

    c. NFPA 101 - Life Safety Code

3. The following U.L. Standards:

    a. UL 864/UOJZ,APOU - Control Units for Fire Protective Signaling Systems

    b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems

    c. UL 268A - Smoke Detectors for Duct Applications

    d. UL 521 - Heat Detectors for Fire Protective Signaling Systems

    e. UL 464 - Audible Signaling Appliances

    f. UL 1638 - Visual Signaling Appliances

    g. UL 38 - Manually Activated Signaling Boxes

    h. UL 1481 - Power Supplies for Fire Protective Signaling Systems

## 1.4 SUBMITTALS

A. Provide standard product data for all equipment indicating the type, size, rating, style, catalog number, and listing of the equipment.

B. Provide calculations for sizing all batteries and power supplies. System Power and battery charts with performance graphs and voltage drop calculations to assure that the

system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.

C. Provide power supply calculations listing total current and inrush total current for FACP, and all Notification Appliance Power Supplies and Power Extender Panels.

D. Provide standard wiring diagrams for all devices.

E. Architectural floor plans and drawings showing system details including specific location of FACP, all system devices, device addresses, raceway sizes, raceways routings cabling in raceways, end of line devices, power supplies and any other system components.

F. Provide a complete riser diagram indicating all devices with addresses, number of initiation and signal loop circuits, class of wiring system, and type of wiring.

G. NICET Certifications for installing contractor(s).

1.5 SYSTEM VENDOR

A. Contract with the facilities fire alarm vendor for products, final connections, programming, and testing:

Simplex, JCI
6850 Main Street - Suite 3
Williamsville, New York 14221
Attn: Tyler Latacki
Office: 716.633.8465
Fax: 716.635.9280
Email: tyler.latacki@jci.com

1.6 SYSTEM DESCRIPTION

A. Contractor to perform minimum modification of the existing fully addressable fire alarm system as described in specifications; replace and install new initiating devices and notifications appliances and connections for control of new fire/smoke dampers as indicated. Extension of existing fire alarm circuits shall be done matching same cable characteristics and type, as the installation and quantity of the fire alarm devices indicated on drawings and this section. The Existing Fire Alarm Control Panel should have the capacity to accept additional devices and appliances for this magnitude of work.

B. Point addressable fire alarm system with automatic initiation devices.

C. Summary Reports:

1. The Fire Alarm Control Panel shall be capable of displaying and printing summary reports. The summary reports shall include:

a. A list of all alarm points not in their normal state.

b. A list of all points in the system, including their current status.

c. A list of data for all control by event programs.

d. A list of data for all time initiated programs.

D. Alarm Priority:

1. Alarms shall be processed at three levels of priority:

a. Fire alarms shall have the highest priority.

b. Other alarms that require interaction by the attendant shall have the second level of priority.

c. Monitored points which do not require interaction by the attendant shall be the lowest level of priority.

E. System Access:

1. Access to the system shall be controlled by at least three levels of security to prevent programming modifications by unauthorized personnel.

a. The lowest level of access, shall permit the attendant to view the system display, print alarms and perform life safety control by event functions. The Attendant has minimal access to the system functions.

b. The mid-level access shall permit the attendant to change user programmable parameters.

c. The highest level of access shall permit the modification of system software. This level shall be accessed only by a qualified representative of the equipment manufacturer.

## 1.7 SEQUENCE OF OPERATION

A. Upon an abnormal condition on the fire alarm system, the appropriate LED (alarm, supervisory, or trouble) shall flash. The panel audible alarm shall pulse for alarm conditions and sound steadily for trouble or supervisory conditions. All abnormal events shall be logged into the database, along with the date and time.

B. Operation of any smoke detector, heat detector, or manual pull station alarm initiating device shall cause the following to happen:

1. Sound all audible alarm signals throughout the building in a temporal Code.

2. Activate all visual strobe lights throughout the building. Strobes shall continue to operate until Fire Alarm Control Panel is reset. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm

annunciator panels and print at all system printers. The visual indication shall remain until the alarm condition is reset.

3. Notify the existing monitoring stations as currently in use.

4. Operate the fan shut-down relay for the HVAC systems in the same smoke compartment or smoke zone.

5. Subsequent initiating alarms shall repeat the respective sequence of operations.

C. The Fire Alarm System wiring and power supplies shall be electrically supervised and report trouble conditions to the fire alarm control panel. Any opens, shorts or grounds on the system wiring shall cause the following to happen:

1. Sound a distinct pulsed audible alarm at the fire alarm control panel.

2. Flash the yellow common trouble LED.

3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.

4. Notify the existing monitoring stations as currently in use.

5. Subsequent trouble alarms shall repeat the respective Sequence of Operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/SUPPLIERS AND EQUIPMENT

A. The project includes modifications to the existing system, the existing system is Simplex 4100ES. All devices, wiring, programming shall be compatible and completed by a approved vendor of the system.

2.2 FIRE ALARM CONTROL PANEL

A. The existing panel is Simplex 4100ES, provide all

B. Where additional power supplies are required, the power supply shall be high efficiency, switched mode type, and shall monitor the incoming line. Upon power outage or brownout conditions, the power supplies shall automatically switch to the batteries.

1. The power supply shall provide internal power and 24 VDC for notification appliance circuits.

2. All output circuits shall be power limited.

3. The battery shall be sized to support the system for 24 hours, and then operate all notification appliances for 5 minutes.

2.3 CONTROL MODULE

A. Addressable device with a form "C" dry relay contact used to control external appliances such as door closers, fans, dampers etc.

B. Relay contact rating:

1. 24 VDC = 2amps (pilot duty)
2. 120 Vac = .5 amps

C. Polling and alarm/active status provided by on board red and green LEDs.

2.4 INPUT MODULE

A. Addressable device used to connect 2 class B analog initiating device circuits.

B. Input circuit wiring requirements

1. Maximum allowable wire resistance - 50 ohms per circuit
2. Maximum allowable wire capacitance - .1uF per circuit

C. Polling and alarm/active status provided by on board red and green LEDs.

2.5 REMOTE TEST STATION

A. provides a remote red LED status indicator and a remote test key switch mounted on a single gang stainless steel plate. Turning the test switch to "TEST" will initiate an alarm and allow the resulting system responses to be verified.

B. Mount device in an accessible location, label cover plate with fire detection system device number associated with test switch and equipment monitoring/controlled.

2.6 MANUAL PULL STATION - DOUBLE ACTION

A. Semi-flush, addressable, dual action requiring push then pull.

B. Spring loaded interference plate, Marked "PUSH",

C. Constructed of red lexan with raised white lettering reading "PULL DOWN".

D. Upon activation, handle shall lock in the alarm condition. A key shall be required to reset the manual pull station. Cylinders shall be keyed to match the fire alarm control panel.

E. Unless directly connected to a central station alarm service, municipal alarm system, or local fire alarm dispatch station, provide a clearly legible sign above each manual pull station stating "Local Alarm Only - Call Fire Department By Telephone".

F. Provide U/L listed NFPA approved STI lexan covers for all pull stations.

2.7 INITIATING DEVICE SENSOR BASE – STANDARD

A. Surface mounted addressable base for initiating device(s) including Heat Smoke and CO, shall receive both communications and sensor power

B. Suitable for wall or ceiling mounting.

C. Designed for EMI compatibility,

D. Provides for magnetic test.

2.8 PHOTOELECTRIC SMOKE DECTECTORS

A. Detector shall operate on a light scattering principal. The detector shall have a photo-optic chamber with an infrared light emitting diode and a high speed light sensing photo diode. Capable of sensing visible products of combustion.

B. Alarm conditions shall be indicated by a steady red glow from the LED mounted on the sensor.

C. Sensor shall be microprocessor based, with electronic point addressing to indicate to the system which device is in alarm.

D. The sensor shall be continuously monitored to measure any changes in sensitivity due to dirt, smoke or humidity. Any buildup of foreign material shall cause trouble signal at the control panel indicating that maintenance is required.

E. Sensor shall be capable of automatic device mapping and day/night sensitivity adjustment.

F. Sensors shall be twist lock mounted to a separate base provided with screw terminals for field wiring. The detector shall be tamper resistant and shall be removable only with a special tool.

G. Provide auxiliary relays and 24 VDC power for elevator capture or smoke evacuation control where indicated.

2.9 DUCT TYPE SMOKE DETECTORS

A. Smoke detector shall be solid state, unipolar type with dual chamber construction and operate on the ionization principle.

B. Capable of detecting both visible and non-visible products of combustion.

C. Self-compensating circuitry to provide stability against aging and dust.

D. Field adjustable sensitivity, pre-set in the factory.

E. Enclosure suitable for mounting on an air duct, with a sampling tube that extends into the duct air stream.

F. Suitable for installation within an air-duct system with air velocities from 300-4,000 feet per minute.

G. Provide a remote LED alarm and key operated test switch for each duct smoke detector. Install remote test switches in visible (below ceiling space) and accessible locations adjacent to each duct smoke detector.

2.10 TEMPERATURE HEAT DETECTOR

A. Self-restoring thermal detector.

B. Rated at 135°F fixed temperature.

C. Device shall be configurable for either rate of rise of fixed temperature.

2.11 VISUAL NOTIFICATION APPLIANCE

A. Individually addressed and controlled multi-candela notification appliance

B. Multi candela xenon strobe with synchronized 1Hz flash rate and with intensity programmable from the control panel or jumper selected as 15, 30, 75, 110, 135, or 185cd.

1. Candela as indicated on drawings, if no setting is indicated on the drawings, set to 15cd.

C. Provide backbox for recessed installations except for installations on existing walls.

D. 24 VDC.

E. Visual strobe shall have the following characteristics:

1. Addressable.
2. Flash rate from 1 Hz to 3 Hz.
3. Pulse duration of 0.2 seconds.
4. Reflector and lexan lens with the word “Fire” imprinted.

2.12 AUDIO-VISUAL NOTIFICATION APPLIANCE

A. Individually addressed and controlled multi-candela notification appliance

B. Multi candela xenon strobe with synchronized 1Hz flash rate and with intensity programmable from the control panel or jumper selected as 15, 30, 75, 110, 135, or 185cd. .

C. Provide backbox for recessed installations except for installations on existing walls.

D. 24 VDC.

E. Audible alarm type in existing building and provide to match existing signal type.

F. Visual strobe shall have the following characteristics:

1. Addressable.

2. ADA compliant.

3. Pulse duration of 0.2 seconds.

4. Reflector and lexan lens with the word “Fire” imprinted.

2.13 BATTERIES AND CHARGER

A. Provide battery and charger to provide 24 VDC standby power for the fire alarm system.

B. Provide lead-calcium maintenance free batteries. Size batteries to permit 24 hours under supervisory condition, and then sound all alarms for 5 minutes.

C. Cell reversal protection.

D. 10 year minimum life expectancy.

E. Battery charger shall be self-regulating, solid state type, capable of full charging a depleted battery within five hours.

F. Install battery charger within the fire alarm control panel.

G. Install batteries with fire alarm control panel or in a vented enclosure located adjacent to the fire alarm control panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. During installation and testing, and prior to the system being put into service, all manual stations shall be appropriately marked "NOT IN SERVICE" by the Contractor.

2. Provide all 120 volt, 60 cycle AC required to power the system and all remote power supplies.

3. Wiring to all initiation and signal circuits shall be two wire class B. A fault on a circuit loop shall cause a trouble alarm to initiate for its associated zone at the fire alarm control panel.

4. All wiring shall conform to N.E.C. Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".

5. Install smoke detectors a minimum of 3 feet away from any air supply or return diffuser.

6. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.

7. Provide and wire fan shutdown relay contacts in series with starters ahead of all control devices.

8. All controlled devices such as smoke dampers, fire dampers, elevator control and door control shall be supervised to within 4’ of the controlled device.

B. Audible/Visible Notification Appliance Installation:

1. Devices shall be installed at eighty inches (80") minimum above the floor, or six inches (6") below the ceiling, whichever is lower, in accordance with ADA guidelines.

2. Audible devices intended for operation in public spaces shall have a sound level of not less than seventy-five (75) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.

3. Audible devices intended for operation in private spaces shall have a sound level of not less than forty-five (45) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.

4. All audible emergency alarm signals shall be at least 15 dbA over the existing sound level within a space or shall exceed the maximum sound level by 5 dbA for at least 60 seconds, whichever is louder. Within areas occupied by persons with hearing impairments, audible emergency alarms must have the intensity and frequency to provide notification of an alarm condition.

5. Do not exceed 80% loading on any NAC power circuit.

C. Wiring:

1. Install all wiring in accordance with manufacturer's recommendations and the National Electric Code.

2. All wiring shall be installed in new metal conduit or surface metal raceway. Surface metal raceway shall be used in finished areas. All wiring in mechanical rooms, crawl spaces and exterior shall be run in conduit. All conduit system junction boxes above ceilings or in unfinished locations shall be painted RED.

3. All wire shall be copper and installed in separate raceway system.

4. Wire and cable shall be #14 AWG size, solid copper, THHN/TWN for horns, manual stations, smoke or heat detectors, waterflow switches, valve supervisory

switches and other initiating and indicating devices. Communication loop wiring shall be shielded in accordance with the Manufacturer's recommendations.

5. Wiring shall be continuous from device to device. Splicing shall be accomplished by use of terminal blocks in locked cabinets keyed alike with the fire alarm control unit, or junction boxes. No connections or splices shall be made underground.

6. Control cabinets shall not be used as pull boxes or raceways. Wiring gutters and locked terminal cabinets shall be used.

7. The Fire Alarm System wiring shall be installed in a workmanlike manner, subject to the approval of the project manager.

8. All harnessing of wires shall be accomplished by use of approved nylon tie wraps.

9. All wiring shall be numbered and color coded in accordance with this Specification.

10. Tests of all wiring shall be conducted for proper connection, continuity, and resistance to ground. The minimum allowable resistance between any two conductors or between conductors and ground is one (1) megohm as checked by a "megger" after all conduit, conductors, detector bases, etc. have been installed, but before the detector devices are plugged into the base or end-of-line devices installed.

D. Routing:

1. All fire alarm system conduits shall be installed either parallel or perpendicular to building structural members.

2. All fire alarm system conduits shall be provided at a height so as not to obstruct any portion of a window, doorway, stairway, or a passageway, and shall not interfere with the operation of any existing mechanical or electrical equipment.

3. All fire alarm system conduits and cable shall be routed to minimize the potential for physical damage, either mechanical or by fire.

4. All fire alarm system junction boxes, pull boxes, terminal cabinets, control enclosures and device backboxes shall be readily accessible for testing, service and maintenance.

E. Wall, Floor and Ceiling Penetrations:

1. All conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.

2. All conduit penetrations of walls, floors, and ceiling shall be sealed around the conduits, restoring the walls, floors and ceilings to their original condition, fire

resistance and integrity.

F. Concealment:

1. Conduit shall be concealed except where shown on the drawings.

2. All conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes shall be concealed in ceiling spaces, electrical shafts or closets in all finished areas.

3. Conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes may be exposed in unfinished areas.

4. All fire alarm system components, including devices, junction boxes, electrical enclosures, relays and device backboxes shall be provided so as to be readily accessible for inspection, testing, service and maintenance.

G. Terminations:

1. All fire alarm conductor terminations shall be on numbered terminals or terminal strips. All fire alarm conductor terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other satiable metal enclosures. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.

2. All connections and end-of-line devices shall be accessible for inspection, testing and servicing.

3. Terminations to terminals other than barrier/pressure plate type terminals shall use crimp-on ring-type or Y-type spade connectors.

4. Splices shall be permitted only when routing of existing conductors prohibits point-to-point terminations in existing junction boxes, terminal cabinets, etc. All such splices shall be provided with new terminal strips with proper labeling in junction boxes, terminal cabinets, etc.

H. Mounting and Labeling of Devices:

1. All fire alarm devices shall be rigidly mounted, using appropriate backboxes, to building structural members, permanent walls, ceilings or fixtures designed for the purpose.

2. All devices shall be labeled with device address or device count as appropriate. Label shall be sticky back type attached to base of device. Label identification shall be consistent with As-Built drawings.

I. Color Coding and Wire Numbering:

1. All conductors entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner.

2. All conductors shall be color coded. Color coding shall be by wire insulation, not taping or banding. The numbering and color coding shall be continuous for each circuit wire.

3. Wires shall be numbered at each connection, termination, and junction point. Wire numbering tags shall be Brady Perma-Code, Westline, or equal.

4. Color coding shall match existing.

3.2 INTERRUPTIONS TO EXISTING FIRE ALARM SYSTEM

A. General:

1. Do not remove any portion of the existing fire alarm system from operation while installing new work without written approval of the Owner's Representative.

2. Pupil occupied spaces must have existing systems maintained during school operation.

3. In order to accomplish the above requirements, temporary wiring and relocations of some existing and/or new equipment may be necessary. These temporary locations should approved by the Owner's Representative and arranged so as to avoid safety problems.

3.3 TESTING - EXISTING SYSTEM

A. Perform the following tests and inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" and Reacceptance Testing chapters in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test visible appliances for the public operating mode according to manufacturer's written instructions.

5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

B. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances. System testing requirements as follows:

1. The Contractor shall conduct a pre-test of the new fire alarm system devices/appliances as wells as required reacceptance testing of the existing modified system as required per NFPA 72. The pre-test shall include testing of all life safety functions with respective contractors (e.g. sprinkler monitoring, fan shutdown, damper closure, door holder release, etc.).

2. Provide documentation of required pre-testing, including pre-testing of all life safety functions such as sprinkler monitoring, fan shutdown, damper closure, and door holder release with responsible contractors. Submit pre-test documentation to Owner/AHJ prior to scheduling final acceptance testing.

3. Prior to the Acceptance Testing with the AHJ, the Contractor shall provide a "Record of Completion" form as identified in NFPA 72 figure 4-5.2.1.

4. Prior to AHJ Acceptance Testing, Contractor shall submit "Statement of Compliance" in accordance with FCNYS 901.2.1" requesting final acceptance test with Authority Having Jurisdiction".

5. After the fire alarm equipment vendor has performed a pre-test of the system, and submitted required documentation, an Acceptance Test of the fire alarm system shall be conducted by the Contractor and the fire alarm equipment vendor with the Authority Having Jurisdiction as directed by the Owner.

6. Contractor Re-Acceptance testing shall include, but is not limited to, functional testing of all new devices/ appliances/equipment, operational testing of 10% of initiating devices not directly affected by the changes, 10% functional test of the system, including at least one device on each input and output circuit, in compliance with NFPA 72 10.4.1.2.

7. Subsequent additions, modifications, and re-programming of the FA system, including custom label changes, shall trigger Contractor Re-Acceptance Testing, and follow-up DASNY Re-Acceptance Testing."

C. Fire-alarm system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

1. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

2. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.4 IDENTIFICATION

A. All system devices shall be labeled in the field.

B. For each added devices provide identification to match existing. Label shall be on exterior of device and on wiring in all boxes.

C. For each shut down relay and/or auxiliary control relay and for specific remote lamps, provide the following:

1. Adhesive backed, engraved lamicoid type labels specifically identifying what the fan shut down relay is shutting down, what relay is controlling or what the remote lamp is connected to.

2. Labels shall be black face with white sandwich color, nom: 1/2" tall x 2" wide, with capital letters not less than 3/16" tall engraved into the surface.

3. Design Equipment: Local fabrication by contractor.

D. Provide label on each power supply indicating power supply designation, 120 volt panel and associated circuit breaker number.

E. All concealed covers for all system outlet and pull boxes installed shall be factory or field painted red.

1. On the inside face of each outlet box cover, Contractor shall provide labeling, indicating; System address, Circuit Number, Horn/Speaker/Strobe Circuit Number, etc.

3.5 CLEANING AND ADJUSTMENT

A. Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by the manufacturer.

B. Occupancy Adjustments: Within one year of the date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit the actual occupied conditions.

3.6 PROGRAMMING REQUIREMENTS

A. Provide documentation of all FACP messages. FACP messages must be approved by the engineer and owners representative, prior to start of system programming. Provide Custom messages as directed.

B. FACP descriptors utilize room/space designations and numbers to be used by the facility

after occupancy and those descriptors shall be approved by the engineer and Owner's representative. Descriptors shall be no longer than (1) full line of characters on the FACP display and shall contain the room number and room use type.

C. Contractor shall allow for two fire alarm system re-programming as directed by the Owner's representative. Contractor shall include all time and travel expenses for (2) two all day site visits for system re-programming during the warranty period.

D. Upgrade Service, Contractor shall include all upgrades that are available within two years from substantial completion. Upgrading software must include operating system and revised licensing.

E. Coordinate device naming convention with owner prior to final programming and remote notification.

3.7 RECORD DOCUMENTS

A. Provide complete set of as-built record drawings and documents.

B. Record Documents shall include all documents required by the Submittal Section of this specification updated to reflect as-built project conditions.

3.8 WARRANTY AND INSTRUCTION

A. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.

B. Provide a minimum of 4 hours of instruction to the operating personnel designated by the Owner's Representative with regard to use and operation of the system. Content of the training shall include:

1. Overview of system operations and modifications included in project.

C. Prior to request for final payment submit a quantity of bound Operator Manuals that shall include as a minimum:

1. Shop drawings.

2. Bill of Material.

3. Manufacturer's equipment description for each piece of equipment, each device and each initiation and control module type used.

4. Record Drawings for fire alarm wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, zones, and wiring requirements. Record Drawings for fire alarm wiring diagram shall show all terminal connections at all panels.

5. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative.

6. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved. (Both new and existing systems).

7. Certificate of Completion, Fire Alarm System Inspection and testing form and all other system acceptance documents as described in NFPA-72.

END OF SECTION 283100